

Industries from Eppawala phosphate deposit

by Professor R. P. Gunawardane
Chairman, National Education Commission

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The rock phosphate deposit at Eppawala was discovered by the Geological Survey Department in 1971. The proved reserve is about 25 million tonnes. Although an inferred reserve of another 40 million tonnes has been estimated this has yet to be confirmed.

In comparison with the other phosphate deposits in the world, Eppawala deposit is unique not only due to its high phosphorus content but also due to its relatively easy beneficiation. However, its solubility is low limiting its direct application as a fertilizer. Nevertheless, it can readily be used as a raw material for the manufacture of a variety of more soluble commercial fertilizers. In addition, it may also be utilized to manufacture many other industrial products.

Low solubility

Ground Eppawala rock phosphate is presently used for perennials such as tea, rubber, coconut and spice crops such as pepper and coffee. Owing to the low solubility of the rock it is not recommended for rice, vegetables, potatoes, chilli, onion and other short-term crops. Imported triple superphosphate (TSP) is used for these crops. In addition, Sri Lanka imports more soluble rock phosphate for some perennials, and small amounts of diammonium phosphate (DAP) for certain nurseries. The total foreign exchange used for this import is around 10-12 million US dollars annually.

The rock phosphate deposit at Eppawala is rich in phosphorus containing about 34-40% total phosphorus expressed as a percentage phosphorus pentoxide. However, its water solubility is about 0.5% and solubility in 2% citric acid, which measures the agronomic availability of phosphorus is estimated

to be about 5%. It has more chlorine than fluorine and therefore classified as a chlorfluorapatite.

Apatite has an extremely stable crystal structure, which can withstand soil weathering conditions. The presence of relatively high chlorine content in Eppawala apatite is a special feature in this mineral. Most phosphate deposits in the world contain more fluorine than chlorine. Chlorine positions in the structural framework of Eppawala apatite are under strain and as such it is relatively easy to replace chlorine with other groups at high temperature. This enhances its reactivity at high temperature leading to more soluble products.

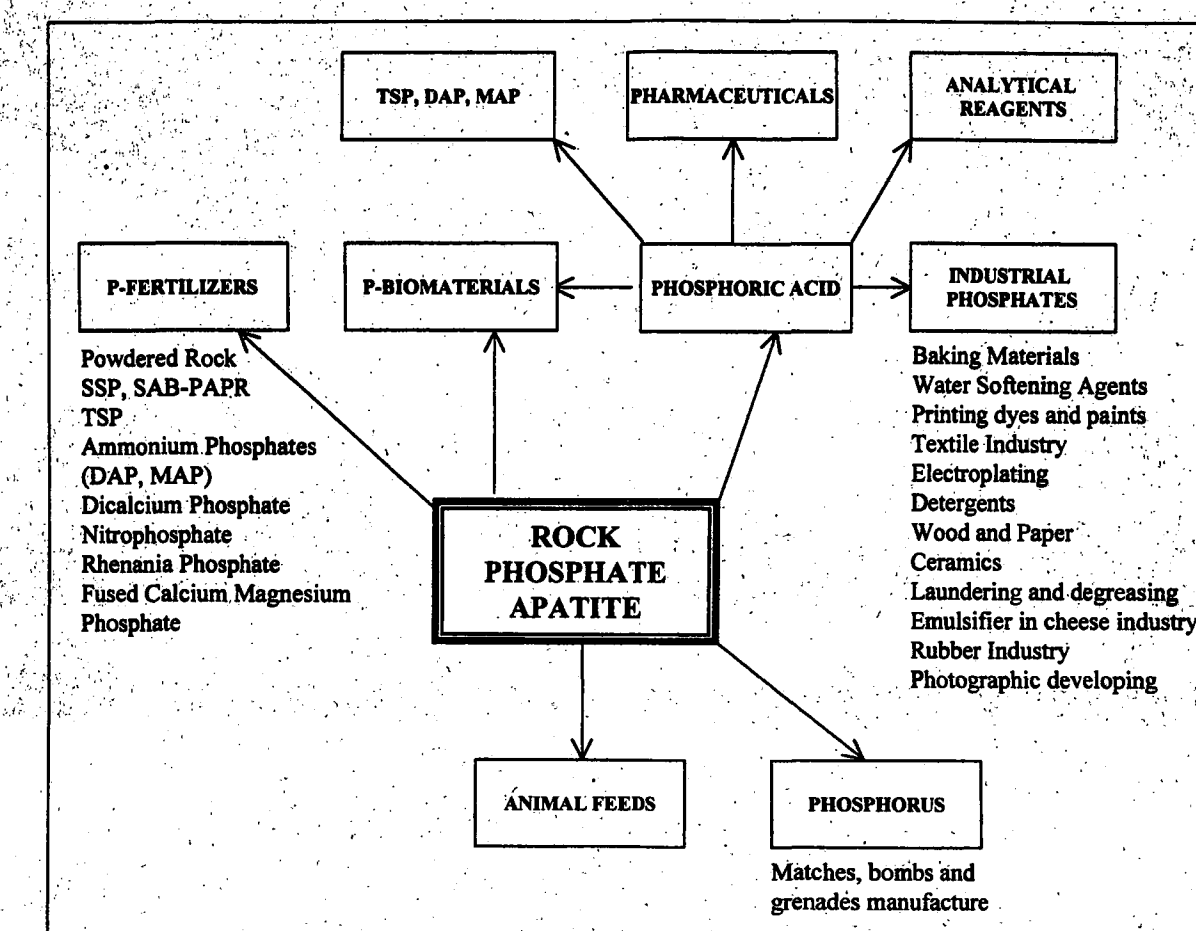
Potential industries

The industrial products that can be manufactured from rock phosphate include P-fertilizers, pharmaceuticals, biomaterials (artificial limbs, teeth, etc.), analytical reagents, animal feeds, phosphoric acid, phosphorus and many industrial phosphates including baking materials, detergents, emulsifiers etc. P-fertilizers include powdered rock, superphosphates (SSP, TSP, PAPP), ammonium phosphates (MAP, DAP), nitrophosphates, rhenania phosphate, fused calcium magnesium phosphates etc. Depending on the nature of soils and the crops grown, widely different phosphate fertilizer products are employed by different countries in the world.

Superphosphates and ammonium phosphates dominate the phosphate fertilizer industry. For instance, DAP/MAP account for 30% while superphosphates account for 29% of the world consumption.

Total phosphate consumption in the world is about 40 million tons annually, of which more than 95% is processed phosphates based on phosphate rock, apatite. The cost of production is highest in DAP/MAP while it is lowest in the powdered rock. Single superphosphate (SSP) has the lowest cost of production among processed phosphates.

The superphosphate family of phosphate fertilizers includes two major products - SSP and TSP.



Industrial Products from rock phosphate

Superphosphates are made by the reaction of ground rock phosphate with sulphuric or phosphoric acid followed by curing. The reaction goes to completion during curing.

Wet process

The phosphate containing component in the product is monocalcium phosphate. SSP contains gypsum (a calcium sulphate) in addition to monocalcium phosphate. SSP and TSP contain about 24% and 45% available phosphorus pentoxide respectively. Phosphoric acid needed for the production of TSP may be manufactured from phosphate rock itself. Wet process involves the complete reaction of apatite with sulphuric acid to produce phosphoric acid. Phosphogypsum is produced as the major by-product of this process and the process requires high technology.

Phosphoric acid may also be produced by a thermal method. In the thermal process phosphorus is produced from apatite by the reaction with coke and silica at 1300 degree C. Phosphorus thus produced is oxidised and the resulting oxide is reacted with

water to produce phosphoric acid.

Ammonium phosphates (DAP/MAP) are produced by the reaction of phosphoric acid with ammonia. The process involves production of phosphoric acid from apatite, production of ammonia and reaction of ammonia with the acid followed by granulation. In addition sulphuric acid is also needed in the phosphoric acid production stage. A large capital expenditure with high technology is needed for such a manufacturing unit.

Nitrophosphate is a generally accepted term for any fertilizer that is produced by a process involving a treatment of phosphate rock with nitric acid. In the nitrophosphate process P-fertilizer is produced completely independent of sulphur. As in MAP/DAP the product contains another important plant nutrient N in addition to P.

Fertilizer products

In this process it is possible to add sulphuric acid and or phosphoric acid or ammonium phosphate to adjust Nitrogen and Phosphorus ratio in the final product.

Thermal phosphates are

produced by heat treatment of apatite with fluxes such as soda ash, dolomite etc. Fusing apatite with fluxes followed by quenching and crushing produces fused phosphates. Thermal phosphate products are not extensively used today because of high fuel costs involved in their production. However, if indigenous raw materials are available such processes may be viable in certain countries.

In the production of soluble phosphate fertilizers from Eppawala apatite due consideration should be given to the geochemical nature and extent of the deposit, local agronomic requirements and cost factors. Furthermore optimum use of local raw materials, low capital investment, plantation requirements and acceptability of the product by the farmers should be given adequate consideration.

In addition to its direct application as a P-fertilizer to perennials such as tea, rubber and coconut, this deposit may be utilized to manufacture the following fertilizers.

(1) Superphosphates:

SSP or SAB-PAPR production involved only the acidulation stage with sul-

phuric acid followed by curing. TSP manufacture involved two stages: production of phosphoric acid by Wet process using rock phosphate and sulphuric acid followed by acidulation of rock phosphate with phosphoric acid.

(2) Ammonium Phosphates:

DAP/MAP may be produced by first producing phosphoric acid using Wet Process followed by granulation of acid with ammonia. Ammonia has to be manufactured locally or may be imported.

(3) Nitrophosphates:

Nitrophos fertilizers are manufactured by first producing nitric acid, followed by complete or partial acidulation of rock phosphate with nitric acid.

(4) Rhenania Phosphate:

Rhenania phosphate (a calcium sodium phosphate) production involves heat treatment of apatite at degrees 900 C with silica sand and soda ash or caustic soda in a rotary kiln for about 2 hours.

After extensive research over 25 years, the Sri Lankan scientists have developed and patented the following processes for the manufacture of P-

fertilizer from Eppawala apatite.

1. Soda ash process to produce rhenania type product with 26% available P

2. Caustic soda process to produce rhenania type product with 26% available P

3. Hydrochloric acid complete/partial acidulation to produce dicalcium phosphate/HCI-PAPR with 16-18% available P

4. Sulphuric acid complete/partial acidulation to produce SSP/SAB-PAPR with 17-20% available P

5. Nitric acid partial acidulation to produce NITROPAPR with 15% available P and 8% N.

All these processes can be used to produce P-fertilizers from Eppawala rock phosphate. These methods utilize simple machinery with low capital cost, use readily available local raw materials and could employ local expertise exclusively for its implementation. Among the processes developed sulphuric acid based partial acidulation appears to be more appropriate for Sri Lanka because of the lowest capital cost, low cost of the product, farmers acceptability and ease of handling and storage of the partially acidulated product.

Considering all the factors the most feasible P-fertilizer products for use in Sri Lanka agriculture would be single superphosphate (SSP) and partially acidulated phosphate rock (SAB-PAPR). However, if further proven resources are established at Eppawala, an export oriented TSP or MAP/DAP production plant may be considered as the second stage of development with or without foreign collaboration.

Exploitation

Up to now Eppawala apatite has been considered only as a raw material for fertilizer industry. It is essential that the production of biomaterials and other important industrial products with much higher value addition also should be given serious consideration. More research is urgently needed in this direction to establish the suitability of

our deposit for these new industries.

It must be stressed that in the development of the Eppawala deposit, it is necessary to employ strategies that will yield maximum benefits to the national economy. This includes provision of powdered rock to meet domestic requirements for perennials, manufacture of more soluble fertilizer for short-term crops such as paddy, vegetables etc. and exploration of possibilities for the production of biomaterials and other new industrial products from this deposit.

It must be realized that this deposit is a non-renewable natural resource situated in a traditional village environment. Thus, environmental aspects as well as social issues at Eppawala village should be given utmost consideration. Alternative industries suggested above may reduce possible environmental hazards and minimize social problems at Eppawala village. In any event, it is essential that the rate of exploitation of this deposit should be carefully controlled so that many future generations could benefit from it.

Establishment of P-fertilizer manufacturing unit based on Eppawala apatite has been long overdue. It is regrettable to note that there is no such plant in operation as yet despite the fact that the deposit was discovered over 30 years ago. At present Sri Lanka spends 10-12 million US\$ (about 1 billion rupees) annually for the import of soluble P-fertilizers. Therefore, there is an urgent need to establish a P-fertilizer plant(s) based on Eppawala rock phosphate.

At present sufficient scientific, technological and agronomic data are available to make a decision regarding this matter. Furthermore, scientific and technological expertise is available locally for the successful implementation of such a proposal. If such a production unit is established it would certainly save about one billion rupees in foreign exchange to this country, leave alone any additional earnings from the export of locally produced P-fertilizer.