

# THE EPPAWELA ROCK PHOSPHATE PROJECT

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## Introduction

The Eppawela Rock Phosphate deposit was discovered by the Geological Survey Department in 1971 during the systematic geological mapping of the 1" to a mile topographical sheet of Anuradhapura. Eppawela is located on the Kekirawa - Talawa road and is almost 175 Kms. from Colombo. The area falls within the administrative district of Anuradhapura and is located in the Mihinthale Electorate.

## General Geology

The rock phosphate occurrence has been identified as a carbonatite complex containing the mineral apatite. The surrounding rocks are mainly chanoekites, granita, granitic gneisses and quartzites of Precambrian Age. It is generally believed that the Eppawela Carbonatite Complex which contains the rock (rock phosphate) rich in apatite is intrusive in nature and post-dates the major metamorphic events.

## Description of Deposit

The rock phosphate deposit is exposed in the form of six hills rising to a maximum altitude of about 250 meters from mean sea-level and covering a surface area of almost 150 hectares. The "Ore" which has been identified occurs in the form of a 'leached zone' forming the 'cappings' of the 6 hills. The average thickness of this zone is almost 75 meters from the crest of the hills. This "ore" estimated at almost 60 million tons (proven and inferred) contains an average of 37% P<sub>2</sub>O<sub>5</sub> and is considered to be the richest phosphate deposit in the world. Open-cast strip mining can be adopted for exploitation of this deposit.

## Mineralogy of the Rock Phosphate

The average mineralogical characterisation of the Eppawela rock phosphate is shown in the table at right.

From the mineralogical composition it is quite evident that the phosphate mineral phases identified are chlorapatite,

francolite and crandallite which constitutes almost 92% (modal) of the rock. This accounts for the high P<sub>2</sub>O<sub>5</sub> (nearly 38%) in the "run-of mine" phosphate rock.

## Chemical Characterisation of the Phosphate Rock

The chemical composition of this average phosphate rock from Eppawela on a dry basis is given in the table at right.

## Suitability of Eppawela Rock Phosphate for Wet Process Phosphoric Acid Manufacture:

Phosphoric acid is the intermediary product for the manufacture of high analyses phosphate fertilizer such as Triple Super Phosphate (TSP), Di-Ammonium Phosphate (DAP) and Mono-Ammonium Phosphate (MAP).

In order to convert the phosphate rock to phosphoric acid by the wet process the rock is reacted with sulphuric acid and gypsum, which is the main by-product in this chemical reaction and act as a natural filter through which the phosphoric acid passes in the acid reactor. The filtration rates are critical in commercial phosphoric acid production.

Although the Eppawela phosphate rock is high in P<sub>2</sub>O<sub>5</sub> (Av. grade over 36% P<sub>2</sub>O<sub>5</sub> or 81% BPL) the high chloride content (0.63-1.1%) and the high iron and aluminium contents (total Al<sub>2</sub>O<sub>3</sub>Fe<sub>2</sub>O<sub>3</sub> - 6.5-9%) will pose serious problems in processing the rock to merchant grade phosphoric acid (54%

	1.	2.	3.
P <sub>2</sub> O <sub>5</sub>	37.0	36.4	36.4
CaO	49.1	48.3	48.5
Fe <sub>2</sub> O <sub>3</sub>	4.29	4.6	4.8
Al <sub>2</sub> O <sub>3</sub>	1.38	1.9	1.9
MgO	0.05	0.13	0.20
Na <sub>2</sub> O	0.14	0.18	0.14
F	2.40	2.5	2.6
Cl	0.63	1.05	1.1
Co <sub>2</sub>	1.14	1.0	1.2
SiO <sub>2</sub>	1.03	1.0	0.8
MnO <sub>2</sub>	0.44	-	0.67
TiO <sub>2</sub>	0.90	0.42	0.66
SrO	0.04	0.70	0.38
BaO	0.007	0.25	0.15
CrO	0.028	0.02	0.01
Cr	0.01	0.01	0.01
Cu	0.01	0.01	0.013
As	-	-	0.004
U	-	-	0.0018
Cd	-	-	0.0005
V	0.001	0.01	0.0004
Hg Hg <sub>2</sub>	-	-	0.10
Fa	-	-	0.10
Total carbon	-	-	0.58
Total Sulphur	-	-	0.03
Sulphate Sulphur	-	-	0.03
NAC soluble P <sub>2</sub> O <sub>5</sub>	-	-	2.8

(Source: IFDC Report - 1980)

P<sub>2</sub>O<sub>5</sub>). The high chloride content (0.63-1.1% or 6300 ppm to 11000ppm) will cause serious corrosion problems in the acid reactor, pumps and pipes of the phosphoric acid plant. The industry standard of chloride levels acceptable is 1.05% or 500 ppm.

From the beneficiation studies carried out it has been confirmed that there is no physical method of beneficiation of the Eppawela Phosphate Rock as the

Mineral Component	Composition	Weight Per cent (Model)
1. Apatite (chlorapatite)	Ca <sub>9.92</sub> Sr <sub>0.08</sub> (PO <sub>4</sub> ) <sub>6</sub> F <sub>1.3</sub> Cl <sub>0.70</sub>	45.5
2. Apatite (francolite)	Ca <sub>9.77</sub> Na <sub>0.17</sub> Mg <sub>0.07</sub> (PO <sub>4</sub> ) <sub>5.92</sub> (CO <sub>3</sub> ) <sub>0.68</sub> F <sub>2.27</sub>	
3. Crandallite	CaAl <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> (OH) <sub>5</sub> H <sub>2</sub> O	
4. Goethite and Hematite	Fe <sub>2</sub> O <sub>3</sub> .H <sub>2</sub> O.Fe <sub>2</sub> O <sub>3</sub>	4.6
5. Ilmenite	Fe TiO <sub>3</sub>	1.3
6. Quartz	SiO <sub>2</sub>	0.8
7. Wad	Manganese Oxide	0.7
8. Wavellite	Al <sub>3</sub> (OH) <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> .5H <sub>2</sub> O	Tr.
Total		99.4

(Source: IFDC Report 1980).

chloride is mainly held in the crystal lattice of the chlorapatite mineral phase.

The high  $Fe_2O_3 + Al_2O_3$  - Iron and Aluminium (I & A) in the rock will drastically reduce the filtration rates in the acid filter as these impurities will form coagulants. The industry standard of I & A in rock for phosphoric acid manufacture by the wet process is 4% and the Eppawela rock averages almost 8-9% I & A.

Briefification tests carried out to separate the two major phosphoric mineral phases i.e., chlorapatite and francolite were successful but both these phases are not suitable for manufacture of phosphoric acid. The chlorapatite when separated has a chloride content of 2.8% and the francolite fraction has a high  $Fe_2O_3 + Al_2O_3$  content of 15-20%.

Therefore the rock phosphate at Eppawela is not suitable for manufacture of phosphate fertilizer by the wet process phosphoric acid route unless the high chloride, iron and aluminium contents are controlled by a chemical process or any other method. This problem is further aggravated by the presence of free fluorides which adds to the corrosion problem. The evolution of free fluorides is mainly due to the low  $SiO_2$  content in the phosphate rock.

Therefore, it must be clearly stated that any project formulation by a foreign collaborator should take into account the serious technical problems that will be encountered in processing the Eppawela rock phosphate. These problems could be mainly attributed to the inherent chemical character of the rock.

### The Project

The Eppawela Phosphate project which is presently under consideration by the relevant authorities of the Government will be mainly export oriented after meeting the local demand of phosphate fertilizer.

It is envisaged that the project will be undertaken by a joint venture where the foreign collaborator will go into partnership with the State Mining and Mineral Development Corporation (SMMDC)

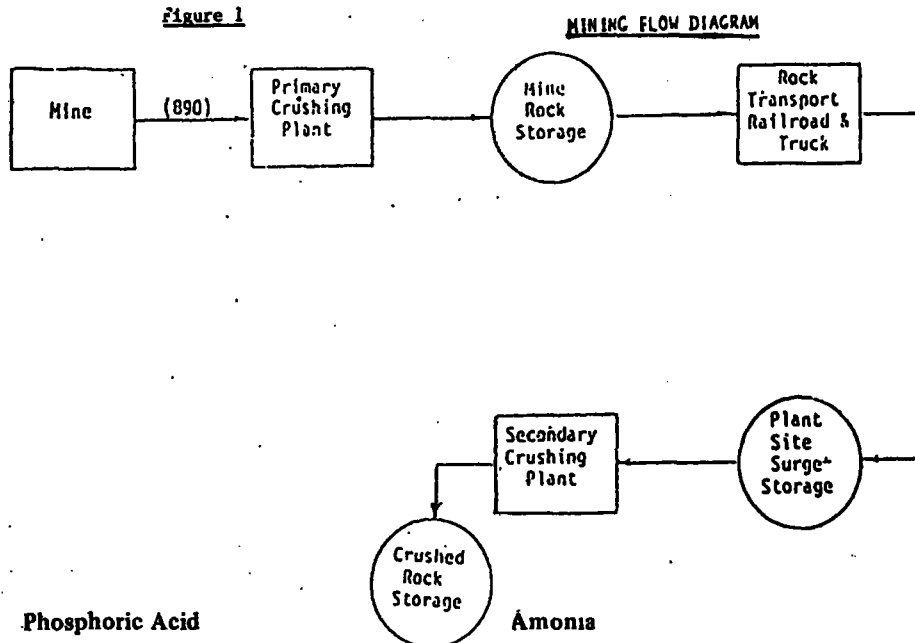
which is entirely owned by the Government. The percentage of equity which will be held by the partners participating in this project and in other commercial arrangements will have to be negotiated with the relevant authorities in Sri Lanka. However, in order to reduce the equity contribution in cash from the Sri Lankan side an upfront payment on royalty for the rock that will be reserved for this project (upto 30,000,000 tons) should be considered by the foreign collaborator. The royalty payments will be from the joint venture.

### The Products

It has been proposed to manufacture the following finished fertilizer products on standard specifications acceptable to the World Fertilizer Trade.

- 530,000 metric tonnes of Di Ammonium Phosphate (DAP) (mainly for export to South Asian and South-East Asian countries) - see figs. - The Sri Lankan product will have a definite freight advantage as compared to other suppliers, see map on inside cover.
- 50,000 metric tonnes of Triple Super Phosphate (TSP) - for local requirements.

Figure 1



### Phosphoric Acid

The basic material for the manufacture of the above fertilizer products will be 255,000 metric tonnes of phosphoric acid per annum. This will require a sin-

gle train 850 metric tonnes per day phosphoric acid plant.

### Raw Materials

The main raw material required for manufacture of 250,000 metric tonnes of phosphoric acid (54% merchant grade) are rock phosphate, and sulphuric acid. The rock phosphate will be mined from the reserves at Eppawela.

### Mine

The mining operation at Eppawela will produce almost 1 million tonnes per year of phosphate rock which will be crushed and ground to - 200 mesh BSS. The actual requirements for the processing plant will be 890,000 metric tonnes per annum. The mine flow diagram is shown in Figure 1.

### Sulphuric Acid

The total requirements of sulphuric acid for this project will be 654,000 metric tonnes per annum. It has been proposed to setup a single train 2,100 metric tonnes per day sulphuric acid plant to meet this requirement. The requirement of sulphur for production of the above will be 216,000 metric tonnes per annum.

### Amونيا

In order to produce DAP or MAP upto 530,000 metric tonnes per annum 133,000 metric tonnes of amonia will be required.

## Sources of Supply of Sulphur and Ammonia

The possibility of entering into long-term supply contracts for sulphur and ammonia from sources preferably in the Middle-East should be explored as it will cut down the freight cost and also reduce the Government commitment on loan guarantees.

## Upgrading Facilities

From the above project description the following upgrading facilities are proposed:

1. A single train sulphuric acid plant - 2,100 metric tonnes per day
2. A single train phosphoric acid plant - 850 metric tonnes per day
3. A single train 2000 metric tonnes per day granulation plant capable of producing DAP/MAP or TSP (capacity making TSP is 1300 metric tonnes per day).

## Materials Flow

The materials flow for the entire project is given in Figure 2.

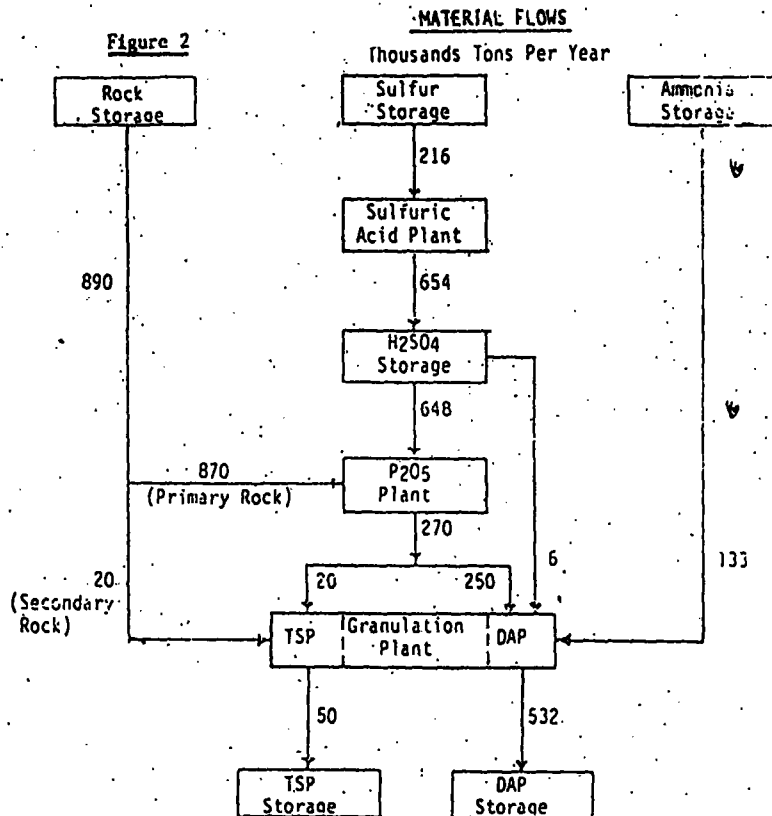
## Infra-structure Facilities

It has been suggested to construct this phosphate fertilizer plant at Trincomalee or Kantalai which has access to a deep water port which is essential for receiving of raw materials and shipping of finished fertilizer. The following infra-structure will be required at both the mine site at Eppawela and the plant site at Trincomalee or Kantalai.

## Rail Road

Construction of 10 Kms of rail road (broad gauge) from Eppawela to Kalawewa on the main Colombo-Trincomalee line has been proposed. The other facilities will include rail spurs, rolling stock including railcars switching and main line locomotives.

- Service roads at plant and mine site.
- 3. Township for employees - 500 at plant site and 350 at mine site. The township will include schools, hospitals and recreation facilities.



4. Water supply pipeline - fresh water requirements at plant site is almost 1,000,000 gallons/day and cooling water (sea water) requirements will be almost 6,000,000 gallons/day.

5. Docking facilities at Trincomalee Harbour to handle 40,000 DWT Vessels - preferably a twin berth jetty.

6. Power - generation facilities.

Cost of Production - The cost of production of DAP as compared with that of an US Central Florida producer is given in Figure 6.

## Capital Costs

The envisaged capital costs including infra-structure facilities are given below:

(1989 escalated figures)	US\$ mn
1. Upgrading facilities	316.2
2. Township	18.9
3. Railroad facilities (off-sites)	47.0
4. Dock facilities	17.6
5. Mine facilities	12.3
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	412.0

In addition to the above capital costs, the following costs will have to be incurred:

Reserve acquisition (upfront payment of Royalty)	- 26.00
Fees (Project development)	- 12.00
Interest during construction	- 67.00
Working capital	- 36.00

Total project costs (escalated to 1989 at 8% per year) **553.00**

## Financial Sources

### 1. Infra-Structure -

World Bank, ADB, IFC or other bilateral lending agencies Government to Government soft loans. Amortisation period 25-30 years. Interest 3%-Grace period-10 years. Outright grants may also be explored. (upto almost US\$ 85 million- may be in the region of US\$ 100 million).

### 2. Processing

facilities - Suppliers/buyers credit Amortisation-10 years Grace period- 4 years Interest 10-11% (316.2 million).

### **3. Commercial**

**loans** Upto about US\$50,000  
Amortisation-7 years-  
Grace period- 3 years  
Interest - 12%

### **4. Rupee loan-local**

**Banks or other**  
**sources** - Upto about US\$ 25,000  
Ammortisation - 5 years  
- 3 years  
Interest - 12%

In order to reduce the Govt's financial commitments particularly issuance of Govt. guarantees on finished products and also guarantees to suppliers of raw material on a long term basis should be explored. The exposure to commercial loans or other loans where guarantees from third parties specially the Govt. should be kept to a minimum. In case the Govt. issues any loan guarantees on the foreign loan component, the Govt will directly hold 50% equity in the Joint Venture and the SMMDC's equity will be only 1% if the foreign collaborator takes 49% of the equity. This arrangement is a legal requirement under the Foreign Loans Act.

#### **GCEC/Registration**

This joint venture could be registered under th GCEC (Greater Colombo Economic Commission) with a Section 17 Agreement. The proposed partners will have to negotiate the various assurances and other concessions expected with the GCEC and enter into a Section 17 Agreement after obtaining the necessary clearances from all Government agencies concerned with this project.