FERTILIZERS FROM EPPAWALA - A GEOLOGICAL AND MINERALOGICAL ASSESSMENT OF A PHOSPHORITE DEPOSIT

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Sri Lanka at present imports a very large percentage of its fertilizer needs at a cost of nearly US $ 60 million per year. Between 15 to 20% of fertilizers used in the country are phosphates-ock phosphates or triple super phos-hates. In 1985, 34,396 metric tons of ock phosphate and 41,600 metric ons of triple superphosphate were im-orted. The local production of rock hosphate was 17,000 metric tons in 985 (Source -. *Review of Fertilizer ecretariat of Sri Lanka* - 1985).

Triple superphosphate (TSP) with a hosphorus (P) availability of about 5% is used mainly for paddy whereas nported rock phosphate (IRP) with hosphorus availability of about 12% used largely for coconut and rubber. ocal rock phosphate (LRP) which has availabilities varying from 2 to 6 was tilized mainly for tea. (see Table 1).

able 1

ERTILIZER CONSUMPTION BY ROP SECTORS (in 1985)

	PADDY	TEA	RUBBER	COCONUT
SP	27973	29	nil	196
LP	25	7640	9146	11618
RP	4	9618	1355	525

ource - Sri Lanka National Fertilizer ecretariat Report 1985) - in metric tons

The need to import phosphate fertilizer has arisen due to the poor availability of P in the phosphate deposits ound in the country. Although many rocesses have been developed to increase the P availability, no detailed ystematic study has been carried out to determine the mineralogical and chemical distribution of the major phosphate deposit discovered at Eppawala more than 15 years ago.

The Eppawala phosphate deposit is located at Eppawelanear Anuradhapura in the North Central Province and is lying at about 200 km from Colombo, capital of Sri Lanka. The deposit occurs as hillocks of about 50 to 100 m local relief. These hillocks are underlain by marble formations which occur interbanded in successions of quartzites, charnockites and different types of gneisses (Fig. 1).

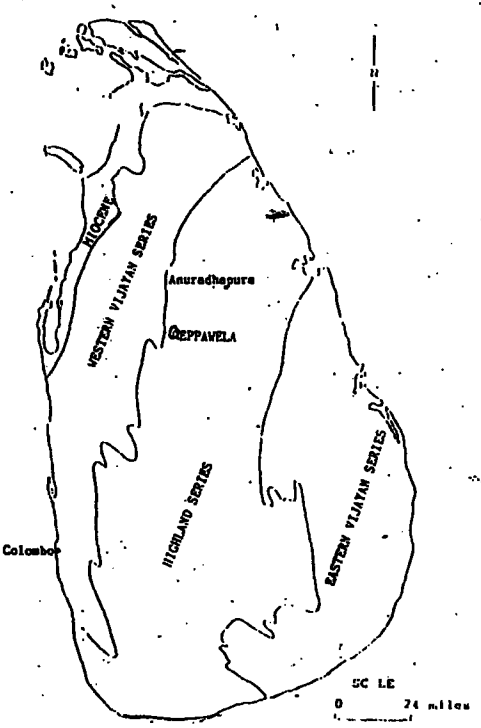

Fig.1 The location of the major geological units in Sri Lanka and the Eppawela phosphorite deposit.

Such metasedimentary rock associations are common in the Highland Series rocks of the Sri Lanka Precambrian. At least two other apatite deposits,though of much lesser extent and different compositions,have been located by the geologists attached to the University of Peradeniya and the Institute of Fundamental Studies.

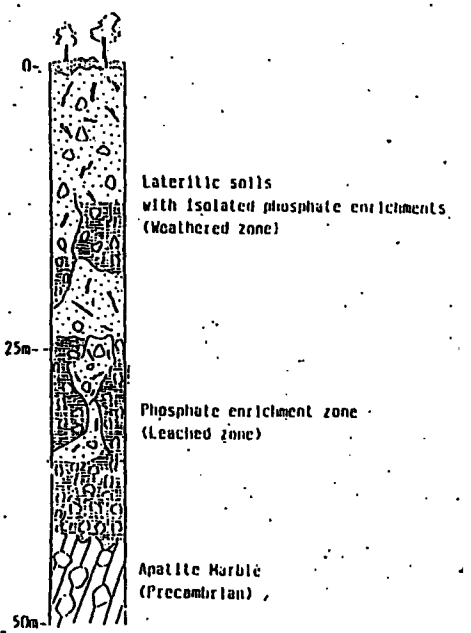

Fig.2 The weathering profile on the apatite marble formation showing the phosphorite deposit at Eppawela.

The apatite occurrences at Eppawala are found concentrated in the weathered and leached zones of the hillocks extending to depths of 30 to 100 m. The leached zones overlie rocks identified as apatite marble. The work already done on the deposit reveals variable compositions within the leached zone of the deposit and also among apatite crystals released from the parent marble rock (Fig. 2).

The Eppawala apatite deposit has been estimated to consist of a reserve of 40 million metric tons of rock phosphate (Jayawardena 1976) and is presently exploited by the State Mining and Mineral Development Corporation of Sri Lanka. The material is crushed and ground to -80 mesh size and is made available for use as a fertilizer after mixing with other ingredients. At the current rate of exploitation, viz. on the average of about 15000 metric tons per year, the Eppawala deposit could be utilized for more than 100 years.

The phosphate deposit consists of P_2O_5 content varying from 18 to 40%

which makes Eppawala deposit one of the important apatite deposits of its type in the world. However, the paucity of knowledge on the exact distribution of P_2O_5 within the deposit has led to haphazard exploitation which is currently being done merely bulldozing the leached zone indiscriminately. A systematic exploitation would not only be economical in the long run but also would lead to optimum utilization of this important ore. Such optimal use could only be achieved if a study of the deposit is undertaken with a view to delineate various mineralogical and chemical assemblage zones particularly on the leached zone.

Table 2 -

CHEMICAL ANALYSIS OF APATITE CRYSTALS AND SAMPLES COLLECTED FROM THE LEACHED ZONE EPPAWALA APATITE DEPOSIT (in wt %)

	Apatite crystals	Phosphate Deposit (from leached zone)
SiO_2	0.22 to 5.0	0.21 to 7.7
TiO_2	-	0.14 to 1.6
Al_2O_3	-	1.10 to 44.0
Fe_2O_3	0.05 to 0.5	2.27 to 16.8
FeO	-	0.09 to 1.77
MgO	0.01 to 0.17	0.10 to 0.29
CaO	50.5 to 55.95	7.2 to 53.03
Na_2O	-	0.08 to 0.19
K_2O	-	0.22 to 0.44
P_2O_5	32.0 to 40.75	19.9 to 37.30
Cl	2.16 to 2.29	0.88 to 1.04
F	54 to 1.78	

To examine the mineralogy of the Eppawala phosphate deposit, we have carried out field and laboratory studies. Field observations show that the mineral deposit extends to about 20 sq km. The deposit occurs as a thick soil profile extending to depths of more than 50 m on a marble rock. The marble rock formation occurs together with other Precambrian (more than 570 million years of age) rocks such as quartzite, gneisses and charnockites. These rocks from part of a greater rock group known as Highland Series (Fig. 2). Highland Series rocks occur in the Sri Lankan Highlands extending from Galle through Daniyaya, Rakwana, Ratnapura, Nuwara Eliya, Kandy, Matale to as far North as Anuradhapura. These rocks had been formed initially in Precambrian ocean basins as sedimentary deposits perhaps as thick as 4 to 5 km. Later, due to the generation of high pressures and temperatures in the deeper parts of the sediment piles, metamorphic rocks had formed. These rocks have come to their present position due to processes of uplift occurrence through millions of years.

The thick soil profile at Eppawala is the product of tropical weathering and erosion phenomena which have occured over thousands of years on the exposed marble rock extraordinarily rich in apatite. As a result of such surficial erosional and depositional phenomena, apatite (the phosphate mineral) has accumulated at least in three forms in this deposit. They are Chlor-fluor apatite, hydroxy apatite and carbonate apatite.

Chlor-fluor apatite crystals are of Precambrian origin whereas the other two apatite types are of secondary origin and much younger in age (perhaps some thousands of years). The apatite accumulations are formed in the lower leached zone of the weathering profile (Fig.3). The upper zone of the profile is poor in apatite but rich in lateritic soils which have derived from the gneissic rocks associated with apatite-rich marble.

In the leached zone or the phosphate enrichment zone of the deposit, the primary Precambrian Chlor-fluor apatite crystals of size ranging from a few mm to several meters could be found in a hardened finer matrix. The hardened finer matrix consists mainly of secondary apatite. The primary crystals have upto 42% P_2O_5 whereas the matrix can have P_2O_5 contents of 18 to 40% depending on the location. The hardened matrix with higher contents also show fine clear-dark alternating laminations and appear as fillings in erosion cavities. The lower P_2O_5 values are due to secondary replacement processes of silicification within the matrix. At such points, the laminated character is obliterated or destroyed. Microscopic observations of the finer matrix of the phosphate deposit show that the laminations are due to stromatolitic type growths. Stromatolites are sedimentary formations wherein microorganisms play a role in binding sediments and precipitating minerals from nutrient-rich solutions. The fine hardened matrix is thus a stromatolitic formation, wherein phosphate-rich minerals such as hydroxy-apatite and carbonate apatite have precipitated with the assistance of bacteria or fungi.

Thus in its texture and composition, the Eppawala phosphate deposit resembles other major phosphate deposits of stromatolitic phosphorite type-elsewhere in the world (eg. Morocco, Israel, India or Australia). Thus, this deposit at Eppawala could be considered as a terrestrial phoscrete phosphorite. A characteristic feature of the Eppawala phosphorite is its low solubility which distinguishes it from those of Morocco or Australia, which have higher solubilities and these could be used as fertilizers without beneficiation. However, Eppawala deposit needs to be beneficiated to produce more soluble fertilizers as will be discussed elsewhere in this publication by other authors.

References

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