VARIABLE MINERALOGY AND SOLUBILITY OF A TERRESTRIAL PHOSPHORITE RESULTING FROM DIFFERENTIAL WEATHERING PHENOMENA - AN EXAMPLE FROM SRI LANKA

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ABSTRACT

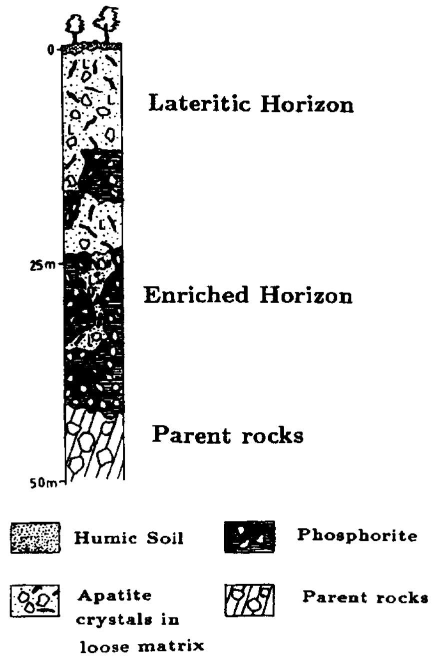
In the hamlet of Eppawala in North Central Sri Lanka, about 200 km from its capital, Colombo, lies a large phosphate deposit with a known reserve of 40 million metric tonnes (Fig. 1). At the present rate of consumption of this phosphate deposit, the ore is sufficient for more than 100 years. Currently, the phosphate material is crushed to fine size and mixed with other ingredients for uge as fertilizer in long term crops such as tea, rubber and coconut.

The phosphate deposit at Eppawala is essentially a thick weathering profile which has developed on a Precambrian apatite marble formation associated with migmatitic gneisses cut by scapolite-diopside dikes. The dikes have in their core a significant apatite mineralisation. Field and laboratory studies on the weathering profile have helped the authors to identify the same as a terrestrial phoscrete-type phosphorite that had formed due to tropical weathering, erosion and sedimentation processes operative on the phosphate rich parent rocks (Dahanayake and Subasinghe, 1989 a,b). The Eppawala phosphorite consists principally of primary chlor-fluor apatite crystals disseminated in secondary sedimentary matrices. These support allochems such as peloids, intraclasts and coated grains - coated grains being mainly primary apatite grains with concentric laminations formed of secondary phosphate. The matrix at points shows ferruginous and clayey regions resulting from the weathering of gneisses and dikes. These deposits are intermingled with stromatolitic laminations (Dahanayake and Subasinghe, 1988).

Based on P_2O_5 compositions, ideally, two compositional zones can be differentiated : (a) lateritic horizon - 10 to 15% P_2O_5 and (b) phosphate enriched horizon -10 to 40% P_2O_5. These two horizons can be found to be associated with each other in a vertical as well as a diagonal sense. Depending on the morphology manifested by the hillock which encompasses the phosphate deposit, and due to merging of the two ideal horizons at certain points, significant local compositional variations could be observed.

The phosphoritic regions of the Eppawala deposit are concentrated mostly on the enriched horizon. However appreciable phosphoritic regions are observed in the lateritic horizon large primary apatite crystals are found in hardened or loose matrices. The phosphoritic horizons seem to undergo several stages of weathering in different microenvironments within the tropical soil profile at Eppawala, when weathered give rise to loose soil regions typified by isolated fine apatite crystals. The weathering produces different types of secondary phosphate minerals.

At least one principal process of secondary phosphate mineralization could be noticed in the Eppawala deposit. The primary apatite grains show a process of grain diminution by way of fine grained microorganism-mediated secondary phosphate mineralizations around their margins. The ultimate products of such phosphate mineralization are called peloids (Soudry and Nathan, 1980). Eventually the



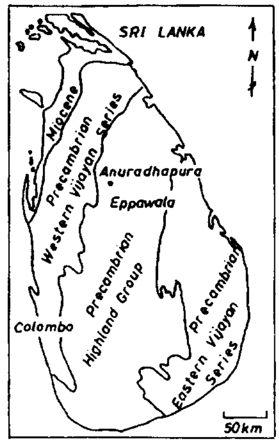


Figure 1 - The location of the terrestrial phosphorite in the Precambrian rocks of Sri Lanka. The weathering profile shows the two ideal horizons of the phosphorite.

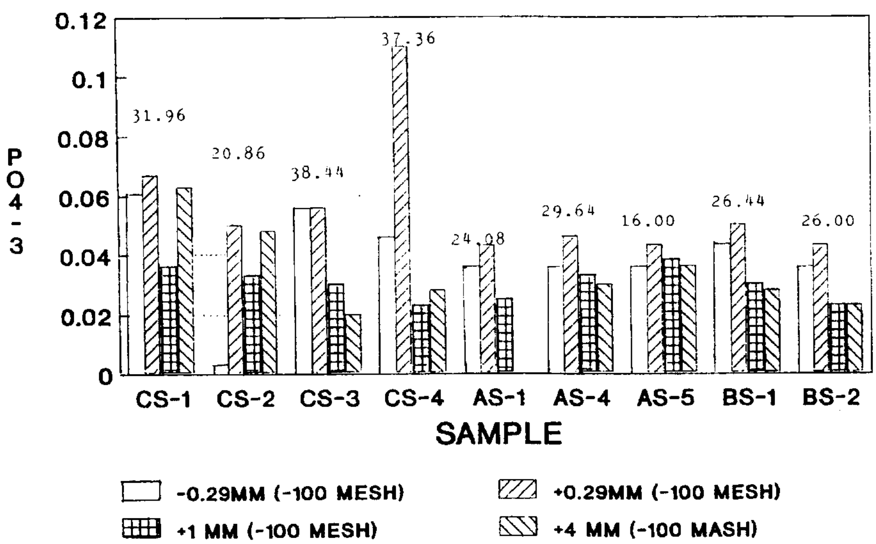


Figure 2 - Water solubility and P_2O_5 variations of different samples of different size fractions (P_2O_5 contents are given in arabic figures above the bars).

peloids will disintegrate to form most of the fine particles associated with the loose soil. At least four types of phosphate-rich material could be identified in the Eppawala deposit : (A) the concentrations of large primary apatite crystals, their maximum length varying from a few cm to more than a meter, in a slightly weathered hard secondary phosphate matrix; (B) Apatite crystals of moderate size - the sizes in the cm range in a moderately weathering loose yellowish soil; (C) fine grains of apatite of size varying between few mm in a weathered loose yellowish red soil; (D) fine grained ferruginous dark brown lateritic soil.

The four different types of phosphate-rich material were selected for mineralogical and chemical studies. It was observed that several secondary phosphate minerals were found in the different size fractions of the same sample. The mineralogies also differed in the same size fraction of different samples. Water solubility varied in different size fractions of the same sample and same size fractions of different samples (Fig. 2). The P_2O_5 content showed marked variations in these samples. These variations stress the necessity of mining the deposit on a selective basis rather than the indiscriminate manner of present mining.

The wide ranging variations at the Eppawala phosphorite deposit are found to originate from the non-uniformity of the parent rocks and the products of differential weathering. On weathering, the apatite marble would release the primary crystals which will be subjected to grain diminution and to produce other allochems. Eventually these primary crystals would contribute to the formation of secondary phosphate matrices of the terrestrial phosphorite at Eppawala. The migmatitic gneiss and the scapolite-diopside dikes will produce clayey and lateritic portions that are disseminated in the Eppawala deposit. The variable P_2O_5 compositions at the phosphorite deposit derived from tropical weathering phenomena, as typified by Precambrian primary apatite crystals in stromatolitic secondary phosphate matrix make it a unique deposit among the phosphate deposits of the world. In most of the marine phosphorites known in Northern Africa and elsewhere, the source for phosphate mineralization is fish bones or shark teeth whereas in this deposit Precambrian primary apatite crystals play the said role thus qualifying it to be different from other phosphate deposits.

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