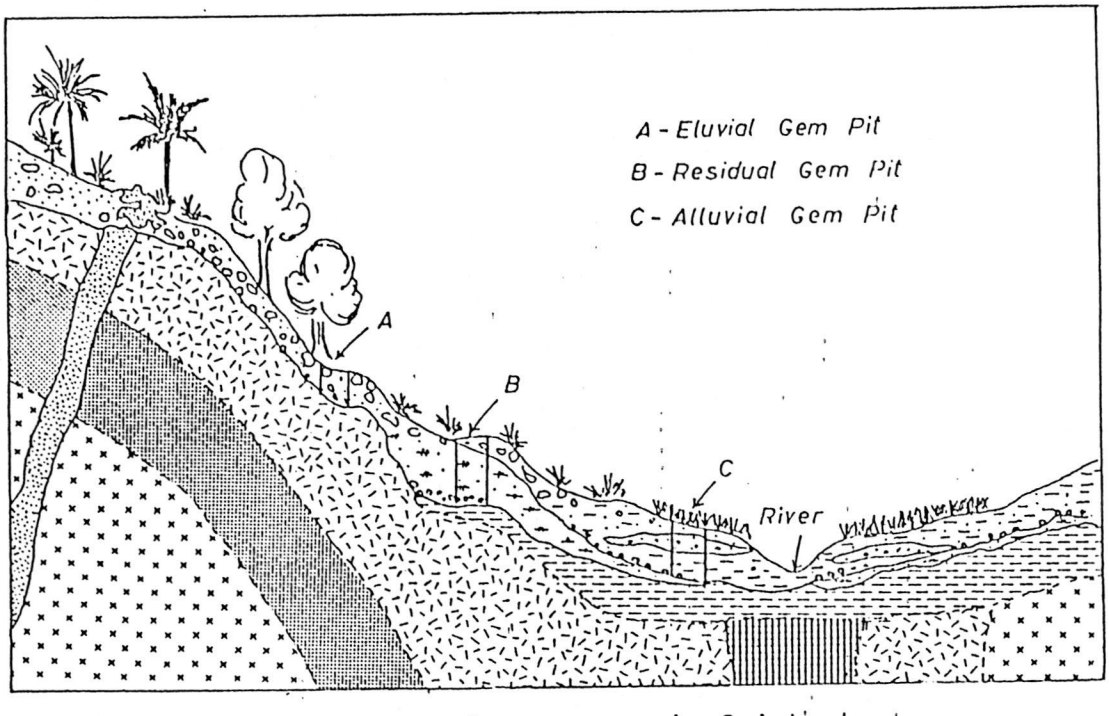
WEALTH UNDER THE GROUND

Programme Leader : *Professor Kapila Dahanayake*

Venue : IFS Conference Hall

Hantana Road, Kandy

4 April, 1987



Modes of occurrence of gemstones in Sri Lanka
(Modified after Dahanayake, 1980 and Rupasinghe, 1986)

Programme Director : *Professor Cyril Ponnamperuma*

Programme Coordinator : *Professor Kapila Dahanayake*

Programme Editor : *Daya De Silva*

TODAY'S PROGRAMME

10.00 am - 11.00 am	*Wealth Under the Ground, by* Professor K Dahanayake
11.00 am - 11.30 am	*T E A*
11.30 am - 12.15 pm	*Gemstones - their nature and origin, by* Dr M Rupasinghe Research Associate, IFS
12.15 pm - 1.00 pm	*L U N C H*
1.00 pm - 2.00 pm	*Valuation of Gems, by* Mr S Malwalage (F.G.A) Nilani Gem House, Ratnapura.
1.30 pm - 2.00 pm	*Film on Gemstones*
2.00 pm - 2.45 pm	*Qualities of Water in Sri Lanka, by* Dr S V R Weerasooriya Research Associate, IFS
2.45 pm - 3.45 pm	*Discussion over Tea* *Panel:* Professor K Dahanayake Professor R P Gunawardane Dr M Rupasinghe Dr S V R Weerasooriya
3.45 pm - 4.15 pm	*Quiz*
	End of the Day's Programme

WEALTH UNDER THE GROUND

by

Professor Kapila Dahanayake

Few people realize the extent to which we all depend on wealth derived from the ground-referred to generally as earth resources. Groundwater is the most critical and valuable of all earth resources. The energy we require, at least a very high percentage of it, is derived from another resource, fossil fuels-petroleum, natural gas and coal.which originate from the decay of marine organisms trapped in bottom sediments of oceans.

The mineral resources obtained from the earth encompasses a wide spectrum of materials such as sand, gravel, which are used in construction; rare metals such as mercury, silver, gold, copper, nickel, zinc, platinum etc., non-metals such as clays, gypsum, sulfur, phosphates etc., abundant metals such as aluminium, iron manganese etc.

Minerals and Rocks

There are about 2500 different kinds of minerals present in the earth's crust-each with its own characteristic structure and a chemical composition. Only a few minerals are economically important. Still fewer minerals are important as rock forming constituents. They are quartz, feldspar, mica, hornblende, garnet, hypersthene and olivine. The most important minerals are silicates and carbonates; silicates because they constitute virtually all of the earth's crust; and carbonates as they are important in decifering the history of the earth.

Rocks are thus described as aggregrates of minerals. There are different types of rocks: some show definite layering or stratification; some are very coarse aggregates of crystals with angular shapes. In the vicinity of volcanoes, rocks formed by solidification of hot lavas are found. Thus, ingenous rocks form when molten material crystallizes ; sedimentary rocks are formed by recementation of particles from older rocks broken down due to processes of physical and chemical weathering. Metamorphic rocks form when igneous, sedimentary or other metamorphic rocks are altered by changes in temperature, pressure or chemical environment.

Rock Cycle

The rock cycle explains the large scale geologic processes that have resulted in the differentiation of the earth. Melting processes in the earth's mantle lead to the formation of igneous rocks. Some of these rocks cool deep in the earth. Others form volcanoes and extrusive lava flows. Weathering processes break down the surface rocks and the resultant material is transported by water, wind, ice to sites of deposition where they eventually become sedimentary rocks. As a result of deep burial, deformation and heating, the sedimentary rocks are metamorphosed. Some of the metamorphic rocks may be heated to their melting points forming new magmatic intrusions; igneous rocks also may be metamorphosed. All three kinds of rocks can be weathered and broken down into the raw materials of sedimentary rocks. (Fig. 1)

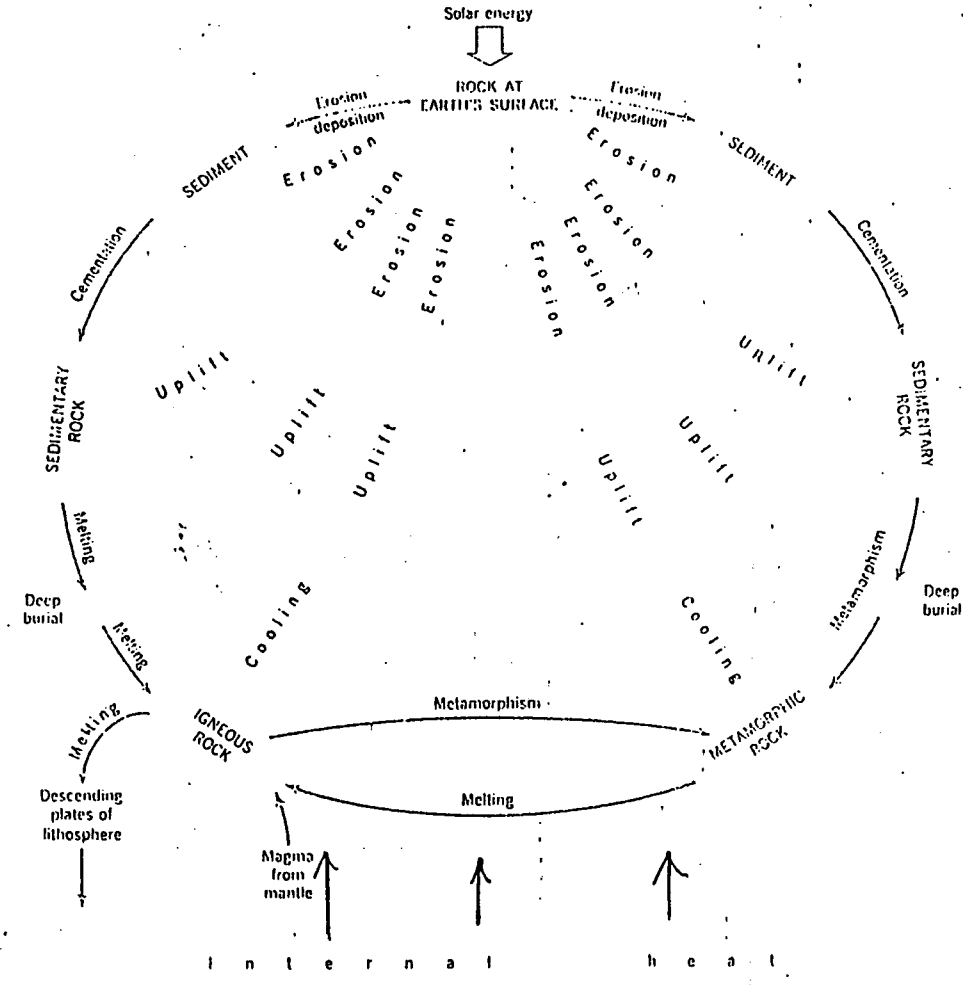


Figure 1 : Rock Cycle

Phosphate Deposits

One of the most critical non metallic minerals in terms of man's well being is apatite $(Ca_5 (PO_4)_3 OH)$ *the most important phosphorus bearing mineral. Phosphorus is essential for plant growth. It is necessary to apply phosphates to crop land subjected to intensive cultivation in order to replenish the original supply.*

Phosphate is a commercial term for a rock, mineral or salt containing one or more phosphorous compounds, phosphorus being the element. Phosphate rock is a term used in a geological sense. In industry, ore is a naturally occurring phosphate too low in grade to be converted economically into fertilizer in a fertilizer plant, whereas 'phosphate rock' is a higher grade phosphorous product- i.e. beneficiated ore that can be used in a fertilizer plant or put directly on croplands. When the natural material is of high enough grade it is also referred to as 'phosphate rock'.

Phosphate rock contains one or more phosphate minerals- usually calcium phosphate in the form of hydroxy-apatite, chloro - apatite or fluoro-apatite. The general formula being $Ca_5 (PO_4)_3$ (F, Cl, OH).F, Cl and OH can mutually replace each other and from pure end members or mixed members -Chlor-apatite, Fluor apatite etc., or Chlor-fluor apatite. The chemical analysis done on these samples will help to identify them as chloro, fluorochlor, hydroxy-apatite etc. Phosphates can occur in sedimentary, igneous or metamorphic rocks. The sedimentary rock known as phosphorite is mined in Morocco and Tunisia and is the widely used phosphate fertilizer. The igneous type (due to the pegmatitic nature and large well formed apatite crystals formed from ultrabasic magmas poor in silica and emanating from the mantle) is called carbonatite.

Eppawela Phosphate Deposit

The phosphate deposit at Eppawela is considered to be a carbonatite by the Geological Survey of Sri Lanka based on studies done by them. However, our observations show that the phosphate deposit is interbanded with metasedimentary rocks. Further due to the frequent presence of spinel in Eppawela deposit and the high chloride contents (>2% Cl) it may may be considered as a metamorphic deposit. However, further detailed field and laboratory studies would reveal more information as to the origin of the deposit.

The Eppawela phosphate deposit lies in the village of Eppawela near Anuradhapura and occurs within metasedimentary rock successions consisting of gneisses, charnockites and marble and some intrusive granites are also observed in the vicinity. The deposit occurs in the form of hillocks suggestive of areas of igneous intrusions. On these hillocks which can rise to about 200 feet local relief, the outer areas show a lateritic appearance with apatite occurring within a matrix of fine grained material and some of the material shows brecciation suggestive of weathering phenomena. This zone is noted in an area of about one square mile and is referred to as the leached zone .

In these conglomerate type of lateritic deposits some analyses show that apatite is in the form of hydroxyapatite and the clayey part shows secondary minerals such as, kaolinite, goethite and gibbsite.

Fluorapatite has also been observed in these lateritic regions. The available chemical evidence suggests that a high concentration of P_2O_5 (between 33% to 37%, Cl 0.8% to 1%, F 1.7% to 2.4% Fluor-chlor apatite) is found in the leached zone just above the underlying fresh marble rock. However, further chemical studies are necessry for the identification of apatite.

Recent studies have shown that there is a proved reserve of 25 million tons of apatite in the northern area and another suspected 35 million tons in the area of Yoda Ela. However, the Eppawela apatite deposit cannot be directly applied to short term crops since it releases phosphate slowly. It has been used in the crushed form in tea and rubber industry. For short term crops such as rice, only superphosphate can be used. In Eppawela samples, P_2O_5 content is higher that that of imported superphosphate, the citric acid solubility is low when compared to other types of phosphates - ie. 1% to 3%; in others it is between 4% to 18%. (Citric acid solubility is the index of effectiveness of rock phosphate to the soil).

A number of commercial methods are available for conversion of apatite to soluble fertilizers. They are acidulation, and thermal methods.

In the acidulation method, apatite can be converted to dicalcium phosphate that can be used as a fertilizer, by treating with HCl (obtained locally from Paranthan) followed by pH adjustment using hydroxide and ammonia.

In the thermal process, apatite is heated with sodium carbonate and quartz in a given ratio at 900^{o} C for two hours in a kiln. The product contains 25% to 28% available P_2O_5. Research relevant to such conversions has been carried out by scientists from Peradeniya and CISIR.

Before mining the deposit one should know the exact vertical and horizontal extents and the nature of the deposit. Currently various studies carried out by different organizations suggest that the apatite at Eppawela can be of different types: chlorohydroxy-, chlor-fluor etc. Detailed geological and chemical studies are necessary to delineate the compositions of the deposit.

The studies already done seems to have been carried out haphazardly and not based on the geological information available on the outcrops. Thus a complete interdisciplinary approach is necessary. IFS has a project expected to be carried out with the help of geologists, geochemists, chemists, agriculturists and chemical engineers drawn from various institutions of Sri Lanka - towards a meaningful exploitation of the Eppawela phosphate deposit.