

SOIL, VEGETATION AND HEALTH

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Abstract

Sri Lanka has clearly demarcated climatic zones, physiographic divisions, soil groups and geological formations. Nine out of the ten great soil groups exist in Sri Lanka and this affords the environmental geochemist an excellent opportunity to study the effect of metals in the soil on human health. The fact that the vast majority of the people of Sri Lanka live in very close contact with the immediate natural environment enhances the usefulness of epidemiological studies in Sri Lanka.

Endemic goitre is widely prevalent in Sri Lanka with an estimated ten million people at risk. Even though iodine deficiency is the chief cause, there may be other factors that are etiologically important.

Introduction

The application of geochemistry to problems of health and environmental studies has been carried out only very recently in Sri Lanka. However, there appears to be many possibilities for the geochemist to make extremely useful contributions to epidemiological studies in Sri Lanka. Sri Lanka offers an ideal opportunity to the geochemist in view of the fact that the vast majority of the people are intimately associated with the natural environment with less than fifteen percent having access to piped water. The geochemistry of the physical environment

governs to a very great extent, the general health of these people and geographic distributions of certain diseases are clearly observed.

Further, out of the ten great soil groups, nine are found in Sri Lanka and this affords an opportunity to the geochemist to correlate health with soil chemistry.

The recent compilation of the Hydrogeochemical Atlas of Sri Lanka (Dissanayake and Weerasooriya, 1985) has provided much new information that could be effectively used for epidemiological studies in Sri Lanka. The "Soil, Vegetation and Health Group" of the Institute of Fundamental Studies has as its objectives the application of geochemistry in studies on dental health, endemic goitre and human cancer.

The Geochemistry of Flouride and the Incidence of Dental Diseases

In a publication on rural water supply and sanitation in Sri Lanka, Pieris (1982) estimated that there are over one million wells spread out all over the island, of which forty percent are used mainly for drinking and cooking purposes, thirty percent for bathing and the balance for both. However, the percentage of safe water remains at ten to fifteen percent greater emphasis is obviously needed in the development of safe water in Sri Lanka.

It is of interest to correlate the fluoride-rich and fluoride-poor areas delineated with natural factors such as climate and geology. Low fluoride areas are situated mainly in the wet zone, whereas the high fluoride areas belong mainly to the dry zone. It is likely that in the wet zone where the average annual rainfall exceeds 500 cms, fluorides are easily leached. Fluoride is known to be easily leached from primary

and secondary minerals and soils under the effect of high rainfall. In the dry zone regions, evaporation tends to bring the soluble ions upwards due to capillary action in soils. This although not the sole explanation for the observed distribution of the fluoride in well water in Sri Lanka, could nevertheless be an important factor. However, it is the geology of the areas that need fluoride consideration. The composition of the rocks in the area, particularly the easily leached constituents coupled with the climate are the key factors in the geochemical distribution of elements in a tropical region. The abundance of fluoride in the rocks and the ease with which it is leached under the effect of groundwater has an important bearing on the abundance of fluorine in the areas concerned and hence the prevalence of dental diseases.

It is worthy of note that the high-fluoride zone of Sri Lanka lies on a mineralized belt at the highland-eastern Vijayan geological boundary. Munasinghe and Dissanayake (1982) in their recent plate tectonic model for the geologic evolution of Sri Lanka suggested that the highland-eastern Vijayan boundary is a mineralized belt. Fluoride being a volatile element is known to be abundant in such tectonic zones and are enriched in rocks found at such locations. Granites are generally rich in fluorine and such granites are found in abundance at the eastern Vijayan complex. Dissanayake and Weerasooriya (1986) studied the fluorine hydrogeochemistry on this tectonic boundary and confirmed the earlier findings that it is indeed a mineralized belt with abundant fluorides.

Recently with the drilling of nearly 7000 deep wells mainly in the dry zone of Sri Lanka, more data on the fluoride distribution in the deeper circulating water, has been obtained. It has been found that some

of the deep wells in the North Central Province and in the areas around Uda Walawe had fluoride concentrations reaching levels as high as 10 ppm, well in excess of the World Health Organization recommended levels. Among the areas containing the highest fluoride concentrations in well water, the regions around Eppawela and Anuradhapura are prominent. Senewiratne and Senewiratne (1975) reported fluoride concentrations as high as 9 ppm, in this region, even in the dug wells. The abundance of fluoride which caused severe dental fluorosis among people of this area can be attributed to an abundance of fluorine in the rocks. It is significant that in this area occurs an economically exploitable deposit of apatite (fluorohydroxy phosphate) known to contain reserves of twenty three million tons. Analysis shows the apatite to contain a fluorine concentration of 1.5 - 2.4 percent (Jayawardena, 1976). The areas around Maha Oya, Moneragala, Sevanagala and Uda Walawe, Hambantota, etc., also show high fluoride concentrations and particular attention should be given to the dental health of the people in these regions.

Nitrates and Cancer

Recent evidence indicates that cancer, after heart disease, is the leading killer in many industrialized societies and is largely due to environmental factors. Epidemiological studies have indicated the importance of the quality of the potable waters, the chemistry of the soils and the plants growing on them in geographically separated areas, quality of the air we breathe and other factors in human cancer. The very fact that certain areas of the world have anomalous incidences of certain diseases, cancer being one of them, clearly indicates that some special features are unique to that environment.

In spite of the usefulness of nitrate and other nitrogenous compounds as essential elements in the life processes of plants and animals, nitrate is potentially hazardous when present in sufficiently high concentrations in drinking water. Although nitrate in itself is relatively non-toxic, it can be reduced bacterially to nitrite in the intestines of new-born infants and may result in the disease methaemoglobinemia. Infant mortality from methaemoglobinemia is rare where nitrate-nitrogen concentrations in drinking water are less than 10 mg/l, but its incidence increases with increasing concentrations (Walton, 1951). Nitrate can also react with other substances, such as amines, in the stomach or lungs to form N-nitrosoamines, which have been found to induce tumours in laboratory animals. Although human tumours are not directly linked to these compounds, exposure to the compounds may pose a risk of human cancer (National Research Council, 1978).

An N-nitroso compound can be formed whenever there is an interaction between a secondary nitrogen group and nitrite. The secondary nitrogen group may be in an amine (giving an N-nitrosamine), an amide (giving an N-nitrosamide), an alkyl urea (giving an N-nitrosourea) or a peptide bond. Tertiary and quaternary amines will often react with nitrite with the elimination of alkyl groups to give N-nitroso compounds.

N-nitroso compounds can be formed endogeneously in humans. They have been identified in vivo in the normal stomach (Sander et al., 1968; Fine et al., 1977), in the achlorhydric stomach (Reed, et al., 1979), in the infected urinary bladder (Brooks et al., 1972; Hicks et al., 1977; Radomski, et al., 1978), in saliva (Tannenbaum et al., 1978) and in faeces (Wang et al., 1978). As noted by Fraser et al., (1980), the conditions in the achlorhydric stomach (high nitrite concentration, large numbers

of bacteria and adequate amounts of amine or amide) are ideal for the formation in vivo of N-nitroso compounds, and their formation has been demonstrated in the gastric juice of such patients (F et al., 1979). Jones et al., (1978) have shown that there is a histological progression from normal gastric mucosa through intestinal metaplasia and dysplasia to carcinoma and a concomitant increase in the mean nitrite concentration in the gastric juice.

Panabokke (1984) in a five-year study on the geographical pathology of malignant tumour in Sri Lanka, presented data on investigations on 24,029 biopsy specimens. According to this study the Northern Province showed the highest incidence (184 per 100,000 population) of malignant tumours in biopsy material among the nine provinces of Sri Lanka. In Southern Province, the incidence was low (37 per 100,000 population). The commonest sites from which malignant tumours arose were oesophagus (13.9 per 100,000 population), buccal region (12.1) and breast (10.58).

Endemic Goitre in Sri Lanka

Fernando et al., (1988) in a major study on the endemic goitre in Sri Lanka showed that the etiology of endemic goitre is multifactorial while the chief causative factor is iodine deficiency in the diet. The prevalence of endemic goitre in some parts of Sri Lanka is extremely high and rates as high as forty four percent have been observed in Horana. The rates in the districts of Chilaw and Matale are low. The study of Fernando et al., (1988) further showed that the endemic belt should be enlarged to include the whole of Uva Province and at least a part of the North Western Province. Nearly ten million people are therefore at risk.

Preliminary studies by the Soil, Vegetation and Health Group of the Institute of Fundamental Studies have shown that the geochemistry of Co and Mn also plays an important role in the etiology of endemic goitre in Sri Lanka.

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