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Geochemistry of endemic goitre, Sri Lanka

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Abstract—A large section of the population living in the wet climatic zone of Sri Lanka is prone to endemic goitre, which is mainly caused by the lack of I. In Sri Lanka, an area in which 40% of the inhabitants are afflicted by goitre, the I content in soil and water was still observed to be high relative to other goitrous regions of the world, indicating the possible importance of other factors such as goitrogens in the aetiology of endemic goitre. Cluster analysis of the geochemical data showed that the endemic goitre region lies in the group with lowest I, alkali earths, Cl, NO^{3-}, Fe and Mn.

INTRODUCTION

NEARLY 75% of the population of Sri Lanka live in rural areas and depend on the immediate physical environment for their food, water and other basic amenities. The geochemistry of soil and water therefore has a marked effect on the health of this vast population and significant correlations exist between the incidence of certain diseases and the geochemistry of some elements (e.g. F and dental diseases). Endemic goitre has recently become a major national health problem in Sri Lanka, with nearly 10 M people out of a population of 17 M at risk. Its prevalence in some parts of Sri Lanka, notably the wet climatic zone, is particularly high, a rate of 44% being observed in the Kalutara District (Fig. 1) (FERNANDO *et al.*, 1987).

Early reports on endemic goitre include WILSON (1954), MAHADEVA *et al.* (1968), GEMBICKI *et al.* (1973) and PIYASENA (1979). In these studies there was very little emphasis on the geochemical aspects of the endemicity of goitre. FERNANDO *et al.* (1987, 1989) carried out detailed surveys and showed that the prevalence of goitre in Sri Lanka is much higher than that indicated in earlier studies.

The present study considers, for the first time, geochemical factors that may have a bearing on the prevalence of goitre in Sri Lanka. The area under study, Angunawela, is a village (Fig. 1) in the central part of Sri Lanka, where a 40% rate of endemic goitre has been reported (CHANDRAJITH, 1987). The soils of the study area are of immature brown-earth type and interspersed by reddish brown latosolic soils.

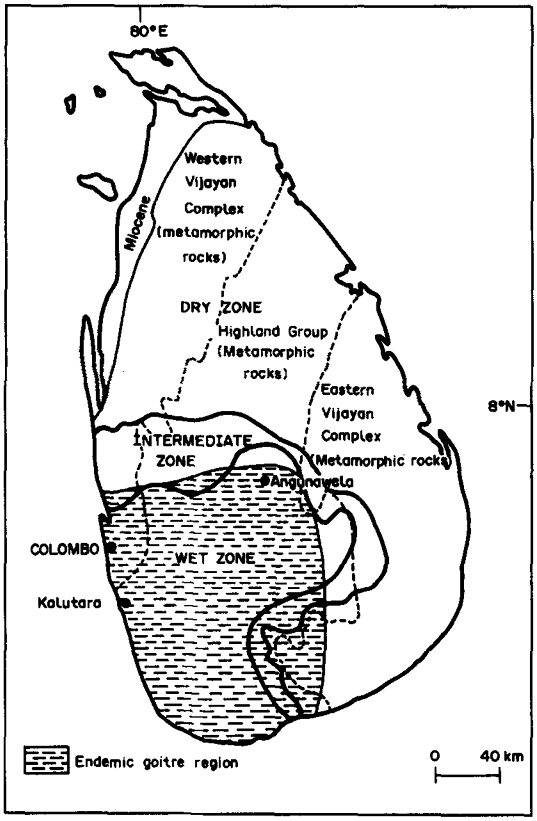

FIG. 1. Geological and climatic divisions of Sri Lanka.

MATERIALS AND METHODS

A total of 120 soil and water samples collected from 60 locations in the area were chemically analysed for the following parameters: pH, alkalinity, F, Cl, I, NO_3^-, Na, K, Ca, Mg, Mn, Fe and total hardness. All chemical tests were carried out using the procedures given in BROWNS *et al.* (1970) and SKOUGSTAD *et al.* (1978). Metal ions were determined by atomic absorption spectrophotometry (Perkin Elmer Model 2380).

RESULTS AND DISCUSSION

Table 1 shows the data obtained for the areas under consideration. About 93% of the drinking

Table 1. Geochemical data on the water and soil in the area studied

Parameter	Minimum	Maximum	Mean
	Water (n = 60)		
pH	5.85	8.2	7.7
Alkalinity (mg/l)	30	420	138
F (μg/l)	44	700	297
Cl (mg/l)	6	108	35
I (μg/l)	15	150	55
NO_3 (mg/l)	1.5	15	8.5
Na (mg/l)	27	1016	512
K (mg/l)	0.55	9.4	7.3
Ca (mg/l)	1.35	1616	50
Mg (mg/l)	0.23	16.64	5.9
Mn (μg/l)	1	208	53
Fe (μg/l)	520	2430	1166
Hardness (mg/l)	7	341	82
Co (μg/l)*	1	23	11
	Soil (n = 60)		
pH	3.8	6.8	5.16
F (mg/kg)	0.4	45	8.4
Cl (mg/kg)	8.0	432	155
I (mg/kg)	0.007	6.5	2.0

*Sample size, 11.

water wells studied have an I concentration of <100 μg/l, with a mean value of 55 μg/l. These are, however, considerably higher than those found in other endemic goitre regions such as northern England, southwest England and Wales (FUGE, 1989).

The I in the soils was low (mean 2 μg/g) by comparison with the soils of the Wariyapola region (Fig. 1) which has an endemic goitre rate of only 11% and a mean soil I content of 9.4 μg/g. The variation of I contents in the two areas demonstrates a possible relation between the incidence of endemic goitre, I concentration and the climate.

The Angunawela region lies in the wet zone characterized by heavy leaching of ions (WEERASURIYA, 1989) while the Wariyapola region, used in this study for comparison, lies in the intermediate/dry zone with flat lying topography. Geologically, both areas consist of similar types of metamorphic rocks, the I content of which are not known. FUGE and JOHNSON (1986), noted however, that the I contents of high-grade metamorphic rocks are very low compared to other rock types. The I contents of soil derived from these rocks are known to be higher.

The Angunawela soils have a pH ranging from 3.8 to 6.7, with a mean of 5.2. In such soil and waters, I occurs as the I^- ion which is easily oxidised to I_2 and volatilized (FUGE, 1990). All previous countrywide surveys indicated that the incidence of goitre was higher in areas of higher rainfall and intense leaching.

Cluster analysis carried out on the geochemical data on water indicated four major groups as follows. Group A: very low total ions; group B: low total ions; group C: moderately high total ions; group D: high total ions. The endemic goitre region around Angunawela falls within group A and is characterized by the lowest content of I, alkali earths, Cl, NO^{3-}, Fe and Mn.

Even though endemic goitre is generally attributed to the deficiency of I in the environment and its low uptake by the human body, there may be other trace elements that are geochemically related to endemic goitre acting as goitrogens. The importance of goitrogens is apparent from this study by the fact that the goitrous region under investigation has much higher I levels relative to other goitrous regions of the world. It is also of interest to note that the Kalutara District, with a 44% rate of endemic goitre, is situated in a coastal region where one would expect high I levels in the diet. Unlike the case of F and dental diseases where a direct correlation exists, the role of I in endemic goitre is more complicated, with other trace elements such as Co, Mn, Se, F, As, Zn, Ca, Mg, Cu and Mo possibly being implicated in the aetiology of the disease. This clearly warrants detailed geochemical studies.

CONCLUSIONS

Geochemical analyses of soil and water in an area with high endemic goitre in Sri Lanka show that in spite of a relatively high I content, goitre persists. This is probably indicative of other factors, particularly goitrogens, playing a role in the aetiology of endemic goitre.

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