COMMITTEE VII
Global 2000 Revisited: Re-assessing Man's Impact on Spaceship Earth

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Discussion Paper on L.T. Khemani's Paper

THE ROLE OF ALKALINE PARTICULATES ON pH OF RAIN WATER AND IMPLICATIONS FOR CONTROL OF ACID RAIN

by

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No 1

Committee V11

Discussion Paper to Acid Rain

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Nowadays, acid rain is a serious problem throughout the world. As the main theme of the conference in Session V11, is reassessing Man's Impact on the space ship Earth, I will introduce today's circumstances for the problem in Japan refering Dr. L.T.Khemani's paper. And also I will make some comments on reducing human impact to the natural environment on the Earth.

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1. Cotribution of particulate on pH of rain water

In general, pH of the rain water is controlled by the equilibrium between atmospheric carbon dioxide and water. As the result of equilibrium, pH of rain water attains to the value of 5.6. But the addition of SO_4^{2-} and/or NO_3^- to rain water, the pH of that is lowered less than 5.6. Theoretically, calcium carbonate particule may reduce the hydrogen ion concentration in rain water. But the particle is not always equilibrium with water, the degree of reaction is the problem of rate of reaction between particle and water.

In this paper, author will introduce the analytical results of particulates collected in Japan. Airborne particulates were collected by Andersen sampler and analysis and identification of particulates concerned with size distribution and compounds, were carried out. The results were shown in Fig.1.

From these results, it is clear that content of calcite particle in the particulates collected in Japan is not main particle. It means that in Japan, calcium carbonate does not make main role to reduce hydrogen ion concentration in rain water. Of course, the distribution and species of compounds in the particulate may change due to sesson and area .

2.Contribution of nitrate to acid rain

In this section author will try to show the role of nitrate in acid rain in Japan. In 1981, more than one hundred of rain samples were collected in Gunma prefecture, as shown in Fig. 2. And chemical analyses of rain water

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were carried out to clarify the cotribution of SO_4^{2-} and NO_3^- to acidify the rain water. The results were shown in Fig. 3, dividing the rain water to three groups considering pH of the samples.

And also ratio of NO_3^- to SO_4^{2-} in equivalent is shown in Table 1.

Table 1 ratio of NO_3^- to SO_4^{2-}

pH of rain	ratio of NO_3^- / SO_4^{2-}
less than 3.5	1.16
3.5 to 4.0	0.82
more than 4.0	0.65
In extreme case 2.86	1.58

It is reported that contribution of sulfate to acid rain is predominant in Europe and United Stats to other anions. But from the results, in Japan the contribution of nitrate to acidifying rain water is very significant comparing to sulfate.

3. Comments on acid rain

In Japan, ecological system is somewhat tolerable to acid environment. For, in Japan, there are many active volcano furnishing acid gas such as sulfur dioxide, hyrdogen sulfide and carbon dioxide as volcanic emanation. For example, amount of sulfur dioxide in volcanic gas of Mt.Sakurajima was estimated as 3000 ton / day in most active period.

Nowadays the amount of sulfur in rain in Japan is about half in United Stats, but the total amount of precipitation on unit area is almost the same. Acid rain may become serious problem in near future in Japan.

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To reduce the concentration of anion contributing to acid rain, such as sulfate and nitrate, it is essential to remove sulfur from fuel namely petroleum or coal by chemical processes. In chemical industry, various methods of removing sulfur in fuel are developed and carried out actually now. Further problem is how to reduce the nitrate concentration in acid rain. Because nitrate is derived from NO_x in atmosphere, and NO_x is formed by the reaction of nitrogen and oxygen in atmosphere contacting with hot bodies such as engine of automobile, stove and oven. Of course, nitrate is one of the fertilizer in nature, but exess nitrate must be reduced in rain water to prevent the acid precipitation.

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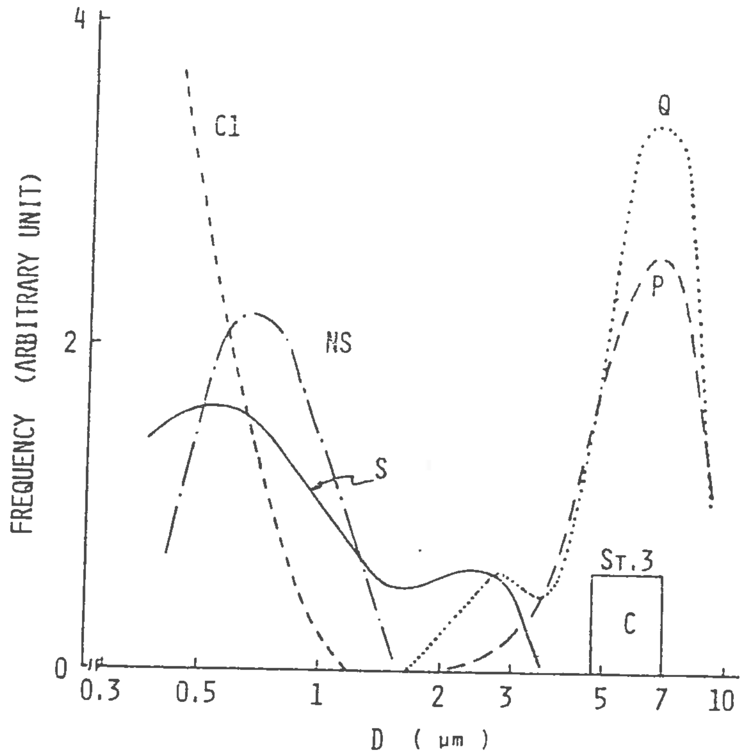

Figure 1

Distribution curves of compounds vs. particle size for particulates collected in the dry season: Cl, NH_4Cl; NS, $(NH_4)_4(NO_3)_2SO_4$; S, $(NH_4)_2SO_4$; Q, α-quartz; C, calcite; P, plagioclase. For *D* and frequency, refer to Figure 1. St. 3: found only in stage 3.

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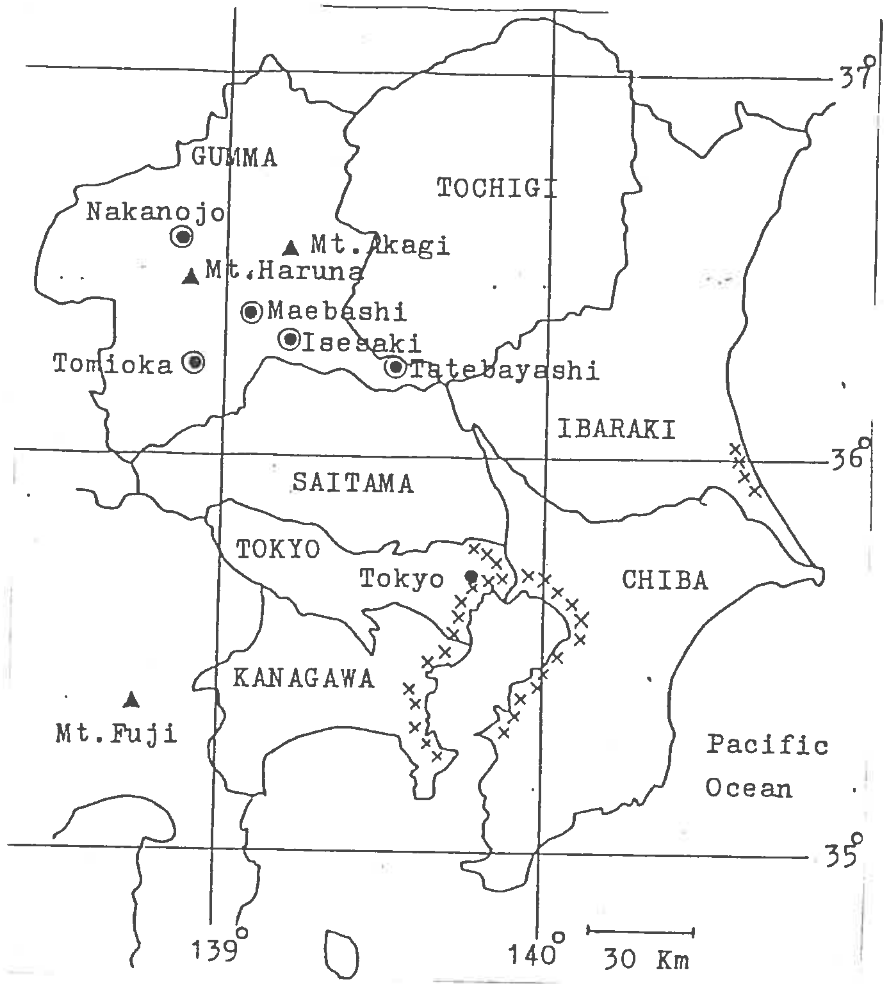

Figure 2
Map of Kanto District,
◉: Sampling Site, ×: Industrialized Area

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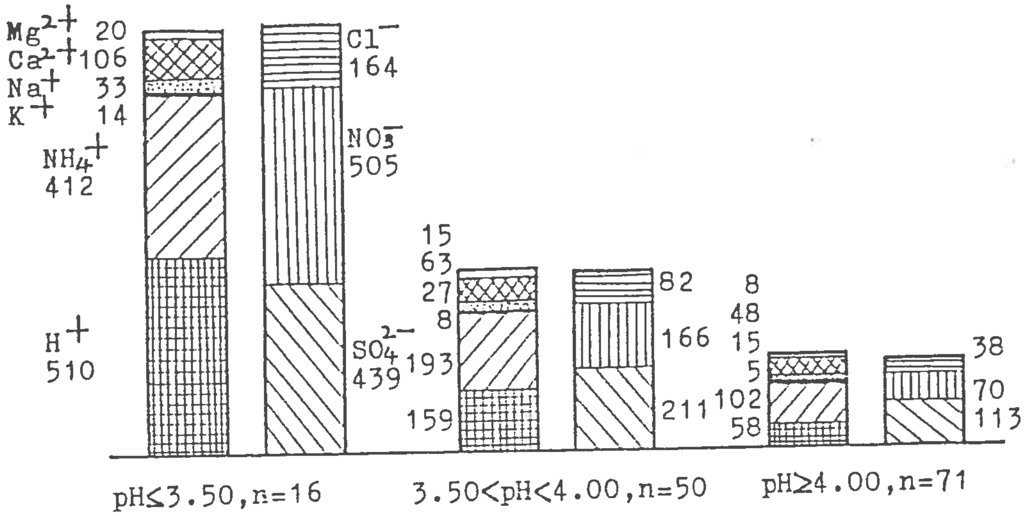

Figure 3

Average chemical composition of the 137 samples classified by pH ($\mu eq\ l^{-1}$)