CHEMICAL COMPOSITION OF KOSA AEROSOL (YELLOW SAND DUST) COLLECTED IN JAPAN

MASATAKA NISHIKAWA¹⁾ and SATORU KANAMORI²⁾

- 1) National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba-shi, Ibaraki 305, Japan, 2) Water Research Institute, Nagoya University, 1 Furo-cho, Chikusa-ku, Nagoya 464-01, Japan

Abstract - Typical Kosa aerosol was simultaneously collected at several sampling sites in Japan, during spring, 1988. After the sample was separated for water soluble fraction and insoluble fraction, many elements and ions in both fractions were determined by ICP-AES and IC. The higher atmospheric concentrations of crustal elements and NO_3^- and Non-sea-salt(nssSO_4^{2-}) were measured in Kosa aerosol than those in non-Kosa aerosol. It can be estimated the surface deposition of NO_3^- and nssSO_4^{2-} during transport to Japan from Chinese arid areas, because of the difference of the concentration ratios against Al in the Kosa aerosol at two remote sampling sites. Though Kosa aerosol is expected to act as a carrier of acidic materials, its alkaline nature may help to mitigate the damage of acid rain in Japan.

Key words Kosa aerosol, aerosol monitoring, ICP-AES chemical constituents

INTRODUCTION

Kosa aerosol, which is transported from the Chinese arid area, is an important source of natural aerosols. The studies of Kosa aerosol have been conducted in various aspects of atmospheric physics[1-2], geochemistry[3-5] and meteorology[6-7]. For instance, Kosa aerosol has been studied for the role of this aerosol as an ice condensation nuclei[1], for the source of sediment to the Pacific Ocean[3], and for the optical characteristics of this aerosol[6]. Recently, it has been reported that the SO_4^{2-} of the Kosa aerosol increases proportionally with aging time during atmospheric transport between China and Hawaii[8]. If the Kosa aerosol react with acidic gases as well as SO_x during transport, it would be expected to remove some of anthropogenic acidic substances. In this report, we present the some results of a monitoring and chemical constituents about the Kosa aerosol which was collected in Japan.

MEASUREMENT

Sampling and Monitoring Sites Two sampling sites for Kosa aerosol were chosen to collected by a high volume sampler, and five monitoring sites were also chosen to measured by a beta-ray absorption system for aerosol monitoring. These sites are illustrated in Fig. 1, which are all remote areas from anthropogenic sources in Japan.

Sampling, Monitoring and Analytical Methods The high volume sampler for sampling was a conventional type (Kimoto Denshi Co. Model 120), which was operated at a constant flow rate of 1000 l/min for 24 hours with a quartz filter (Pallflex 2500QAOT). An Andersen sampler was also operated at a flow rate of 28.3 l/min for 24 or 48 hours. For chemical analysis, two pieces of circular samples of 4 cm diameter were punched out from a high volume sample, then were extracted with 20 ml of double distilled water for determination of soluble fractions by an ion chromatograph (IC, Dionex Model 10) and an inductively coupled plasma atomic emission spectrometer (ICP-AES, Jarrell-Ash Model 975), and water insoluble fraction was digested with mixture acids ($\text{HNO}_3 + \text{HClO}_4 + \text{HF}$). The analytical procedure is shown in Fig.2. An Andersen samples were treated by almost the same procedure.

A beta-ray monitoring system measured for atmospheric aerosol concentration every hour. The lower limit of aerosol concentration by this method is approximately $10 \mu\text{g}/\text{m}^3$.

Fig.1 Map of the sampling and monitoring sites in Japan

Fig.2 Analytical Procedure for Kosa aerosol

Fig.3 Monitoring results for Kosa aerosol by beta-ray absorption system at five monitoring sites

RESULT AND DISCUSSION

Monitoring Data by Beta-ray Absorption System Three typical Kosa phenomena occurred in every place in Japan in April 1988. Figure 3 shows the one of monitoring result by the beta-ray absorption system in the Kosa phenomenon during April 13-14, 1988. It is revealed that the appearance time of Kosa phenomenon gradually becomes later and also the peak concentration gradually decreases from Nagasaki to Chiba, according to the wind blowing from the Chinese continent. The average moving speed of Kosa aerosol is estimated to be approximately 50 km/h from Fig.3. A beta-ray absorption system is used for the Kosa aerosol monitoring.

Table 1 Comparison of the chemical composition between Kosa and non-Kosa aerosols at two remote sampling sites

(1988)	Yaku Island		Wajima(Noto peninsula)	
	Mar.28-29	Apr.13-14	Mar.29-30	Apr.13-14
	B.G.	Kosa	B.G.	Kosa
NH ₄ ⁺	1260	1350	1410	661
Cl ⁻	6780	5460	5260	3010
NO ₃	457	3790	1250	2690
SO ₄ ²⁻	5690	8220	5100	7010
nssSO ₄ ²⁻	840	3650	210	3430
Na	5770	5980	4500	4090
Na ⁺	5600	3580	4300	2650
Mg	758	5370	610	2280
Al	(380)	21400	(930)	9090
K	360	6510	620	2980
Ca	420	12300	810	5540
Ti	45.3	1220	69	540
Mn	4.8	298	13	128
Fe	180	12400	540	4880
Cu	31	67	15	56.4
Zn	23	74	29	55
Sr	(6)	77	(8)	35.1
Ba	(1.5)	217	15	78.8
Pb	21	31	30	30.8

B.G.: Background aerosols at each sampling site
during the non-Kosa period

Non-sea-salt sulfate concentration is calculated by
the following formula;

$$\text{nssSO}_4^{2-} = \text{totalSO}_4^{2-} - (2.67 \times \text{NH}_4^+ + 0.251 \times \text{Na}^+)$$

Chemical Composition of Kosa Aerosol The chemical compositions of both Kosa and non-Kosa aerosols taken by high volume sampler at different two sampling sites are shown in Table 1. Crustal elements such as Al is remarkably increased in the Kosa aerosol as compared to those in the non-Kosa aerosol. It is indicated that Kosa aerosol is originated from the soil dust happened in the Chinese arid areas. NO_3^- and nssSO_4^{2-} concentrations in the Kosa aerosol is also increased. Furthermore, both ions concentration ratios against aluminum at Wajima is higher than those at Yaku Island. NO_3^-/Al and $\text{SO}_4^{2-}/\text{Al}$ at Wajima are 0.30 and 0.38, and 0.18 and 0.17 at Yaku Island, respectively. If NO_3^- and nssSO_4^{2-} are contained originally in the mineral dust, these ion ratios against Al should be constant, irrespective of the sampling site where is different distance from the Chinese arid areas. On the other hand, if NO_3^- and nssSO_4^{2-} are deposited onto Kosa aerosol during the transport, those ratios will be gradually high according to the distance of transport. Though Kosa aerosol is regarded as the carrier of those acidic ions, the collected Kosa aerosol in Japan may have not enough to be neutralized by those ions. Because, Calcite mineral which has the alkaline property exists plentifully in the Kosa aerosol. The fallout amount of Kosa aerosol to Japan in a year is estimated about 2 ton/km² from our investigation as to beta-ray absorption system such as Fig.3. The phenomena, that Kosa aerosol having alkaline property is usually transported from China every spring season, are very important in mitigating some damages to the soil, plants and artificial status caused by acid rain in Japan.

REFERENCES

1. K. Isono, M. Komabayashi and A. Ono, *Nature*, **183**, 317-318 (1959).
2. K. Isono, M. Komabayashi, T. Takeda, T. Tanaka, K. Iwai and M. Fujiwara, *Tellus*, **23**, 40-59 (1971).
3. M. Uematsu, R. A. Duce and J. M. Prospero, *J. Atmos. Chem.*, **3**, 123-138 (1985).
4. R. Arimoto, R. A. Duce, B. J. Ray and C. K. Unni, *J. Geophys. Res.*, **90**, 2391-2408 (1985).
5. S. Tsunogai, T. Suzuki, T. Kurata and M. Uematsu, *J. Oceanogr. Soc. Japan*, **41**, 427-434 (1985).
6. K. Arao and Y. Ishizaka, *J. Meteor. Soc. Japan*, **64**, 79-94 (1986).
7. Y. Iwasaka, H. Minoura and K. Nagaya, *Tellus*, **35B**, 189-196 (1983).
8. J. M. Winchester and M.-X. Wang, *Tellus*, **41B**, 323-337 (1989).