Features of Mineral Dust Aerosols collected in the Free Troposhere over Dunhuang, China

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Introduction

Asian dust, known in Japan as "KOSA" (literally, "yellow sand"), makes important contributions to environment changes, through transport of huge amount of mineral dust and chemical/physical modification on dust particles during their transport.

Some investigators have suggested that the geochemical cycle of minerals is affected not only by severe KOSA events but also by weak KOSA events which is so small they can hardly be detected near the ground (Iwasaka et al. 1988). The weak KOSA events over Japan and the Pacific Ocean have been suggested to occur even in summer (Matsuki et al., 2003). Additionally, it was confirmed that dust particles predominated in the coarse mode particles ($d>1.0\mu m$) in the free troposphere over Dunhuang, China (40°00'N, 94°30'E) even in summer (Iwasaka et al. 2003; Yamada et al., 2005). However, there has been very little information on elemental composition and modification degree of dust particles by sulfur in the free troposphere over main KOSA source areas.

We made electron microscopic analysis of the free tropospheric particles over Dunhuang, China, which is located in the eastern part of the Taklamakan Desert and has been suggested to be an important source of Kosa particles. Their particles were collected in the three different layers—3–5 km, 5–7 km, and 7–9 km above sea level—with a balloon-borne aerosol sampler equipped three low-volume impactor in spring of 2003 and 2004, and in summer of 2002 (Table.1). The balloon-borne sampler used here has been described in detail elsewhere (Iwasaka et al. 2003; Yamada et al. 2005). The aerosol samples collected in the free troposphere were successfully recovered within several hours after particles collection, and thereby prevented contamination by the surrounding air. The distance between balloon launching and landing positions was about 12 km on August 2002, 48 km on March 2003, and 39 km on March 2004.

The particles collected on the Ni grids were examined their shape, size, and elemental composition, using a scanning electron microscope (Hitachi, S-3000N) and an energy dispersive X-ray analyzer (EDX; Horiba, EMAX-500). The diameter of a particle was calculated as the arithmetic mean of the longest width and the width orthogonal to it.

Table 1 shows the weather conditions of observation date. The weather during all the

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balloon-borne aerosol samplings was fine and clear. The balloon affected by easterly wind near the ground except on March 24, 2003, but the wind speeds on the ground were low. Wind direction always indicated the westerly wind in the free troposphere.

Table 1. . Sampling time and weather conditions.

Date	Time (GMT)	Altitude (a.s.l.)	Sampling time	Wind		Weather
				Direction	Speed (m/s)	
29-Aug-02	3:31:12–3:37:12	3.2–5.2 km	6 min	NNE–WNW	5	Fine
	3:37:12–3:42:27	5.2–6.9 km	5.25 min	NW	9.2	
	3:42:27–3:45:27	6.9–8.0 km	3 min	NNW–WNW	14.3	
24-Mar-03	1:52:07–2:00:52	3–5 km	7.75 min	W	11.6	Fine
	2:00:52–2:07:07	5–7 km	6.25 min	WNW–W	16.8	
	2:07:07–2:13:37	7–9 km	6.5 min	WNW	18.6	
22-Mar-04	4:29:35–4:34:35	3–5 km	5 min	SW–NNW	12.3	Fine
	4:34:35–4:39:35	5–7 km	5 min	W–NNW	20.1	
	4:39:35–4:44:05	7–9 km	4.5 min	NNW	33.3	

The total numbers of particles analyzed by EDX were 274 on March 2003, 596 on March 2004, and 535 on August 2002. In the free troposphere over the KOSA source area, dust particles constantly existed even in summer (Iwasaka et al. 2003; Yamada et al., 2005), but the elemental composition of individual dust particles significantly differed between the result of March 2003 and others. Si-rich particles were a dominant type of the dust on March 24, 2003, and account for 73% in the total coarse dust particles. On the other hand, evaporite particles such as Ca- and Na-rich stood out at the results of August 2002 and March 2004, although Si-rich particles were a main type of dust as usual. The mixing state of aerosols collected in the free troposphere on March 24, 2003 seems to be reflected dusty condition influenced by dust storm occurred in the Taklamakan Desert, based on the air-mass backward trajectories, SYNOP data, and concentration and mixing state of dust particles. It might indicate tendencies that the number content of Si-rich particles relatively increases during dusty condition, and evaporite particles become standing out during clear condition because Si-rich particles decrease.

In order to investigate the modification degree of KOSA particles in an initial stage, we estimated the number fractions of mineral dust particles significantly modified by sulfur. The modified dust particles are defined by assuming that; (a) a dust particle has elemental weight ratio of S/(Ca+Na) > 1, or (b) a dust particle contains sulfur without calcium and sodium. The result suggests that 4% to 10% of mineral dust particles collected in the free troposphere over Dunhuang and less than 3% of dust particles had been modified by sulfur significantly. Although not shown here, other site data (e.g., near the surface in Qingdao during dust storm, in the free troposphere over Japan) are available to compare with the result of Dunhuang. At the symposium we will discuss the modification degree of dust particles by sulfur during long-range transport, through the comparison between the dust particles collected in the free troposphere over Dunhuang and those collected in other sites.

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