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Mineralogical and Chemical Features of Dust Particles Collected in the Troposphere over Desert Areas and over Japan

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Continental China has been recognized as one of the most important sources of atmospheric mineral dust particles. Many investigators have pointed out the importance of study of the long-range transport of mineral dust particles and their modifications in this process even during the non-dust storm periods. Because of these modifications, particles can change their radiative properties and ability to be a condensation nucleus. Those modifications depend on atmospheric conditions during the transport and on particles mineralogy. It is important to compare particles features before and after long-range transport to clarify modification processes. A number of investigations have been carried out on the subject; however, mostly those investigations were made for ground-based measurements. In this study some features of particles collected using balloon-borne Automatic Aerosol Sampler (AIS) over the Dunhuang (China) are investigating and comparing with results of airplane-borne measurements over Japan.

Aerosol particles were collected in Dunhuang (40°09'N; 94°41'E), China in different seasons and different atmospheric conditions during the balloon-borne and ground-based measurements. Also particles were collected in spring and summer during the aircraft-borne measurements over Japan. For particle collection 2-stage low volume impactor were used. The particles were collected on top of a carbon-coated nitrocellulose film on the surface of nickel or copper grids. Morphology of individual aerosol particles and their elemental compositions were examined with a scanning electron microscope (Hitachi, S-3000N) equipped with an energy dispersive X-ray (EDX) analyzer (Horiba, EMAX-500).

According to particles morphology and spectra it was divided to following general groups: Si-rich particles, non-Si mineral particles, S-rich particles, and anthropogenic particles. Analyzing the elemental composition of mineral dust particles we determined the major minerals composing the particle. For the Si-rich particles three major groups were defined: Quartz particles, Feldspar particles, Clay&Mica particles. Albite, Orthoclase, Anorthite, and Mixed spars subgroups were defined in Feldspar group, but for the Clay&Mica group general problem for mineral identification were found. For the Non-Si minerals following subgroups were defined: Sea salt and Halite, Calcite, Gypsum, Other sulphates, Dolomite, Thenardite, Magnesite, Fe-rich, Anatase, Ilmenite, Sphene and Apatite particles. Particles morphology and composition were also investigated to understand the mixing state of mineral particles with sulphates.

Aerosol particles, collected over Dunhuang were mainly mineral in coarse mode, but for the fine mode in many samples sulphate particles were found. Portion of sulphate particles were different in different samples, but from the results of the balloon-borne measurements it can seen that their portion is usually increasing with increasing altitude in the troposphere. Balloon-borne Optical Particle Counter (OPC) and Lidar measurements confirming the presence of dust particles layers in the troposphere over Dunhuang in all seasons. Trajectory analysis shows high potential of those dust particles to be transported long-range to the troposphere over east Asia and north Pacific.

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Significant changes in portions of different particle types in the different samples were found over Dunhuang, and those differences are mostly due to the origin of particles. Si-rich were dominated in most samples (Fig.1), followed by carbonates, such as calcite and dolomite. But for the few balloon-borne samples abnormally large fractions of non-Si minerals were detected. Assuming that such minerals having large potential to be modified during the long-range transport it's important to take this fact into account while studying effects of the mineral aerosols in the troposphere.

Over Japan in the mid and high troposphere mineral particles were found to dominate in coarse mode not only in spring (Trochkine et al, 2003), but also in summer (Matsuki et al., 2003). In both seasons portion of mineral particles internally mixed with sulphate becomes significant compare to troposphere over Dunhuang. Some particles mixed with sea-salt was also found, but corresponding mixing ratio is negligible compare to results of ground-based measurements in Japan.

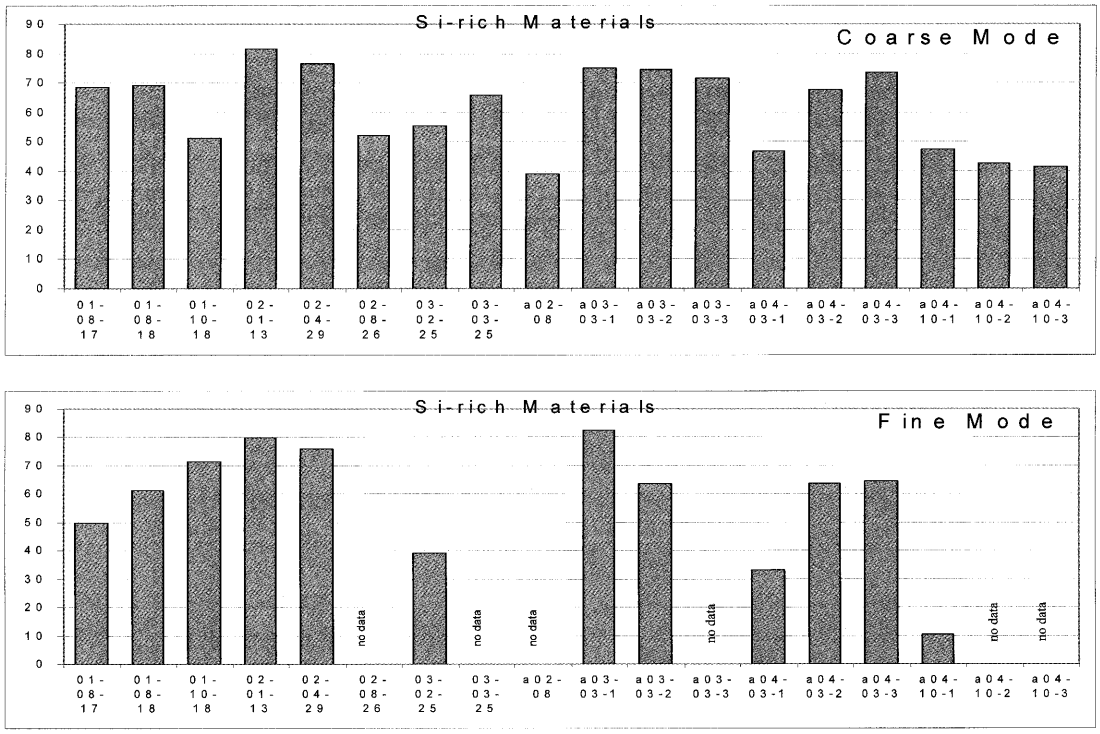

Fig.1 Portion of Si-rich particles in all mineral particles for the different samples collected in the troposphere and near the ground in Dunhuang, China.

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