On the mineral compositions of clays in Asian dust

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Asian dust (kosa in Japanese) is small particles of minerals originating from Chinese or Mongolian deserts, which travels to eastern regions by wind action. Precise knowledge about the mineralogical features of Asian dust is a basis for understanding material transport and heat balance phenomena at Earth's surface. Although the bulk chemical and XRD analyses were performed numerously, mineralogical characterization of the clay minerals, the main constituent in the dust, have not been fully examined. In this study, clay minerals in Asian dust have been studied in detail to verify their species, chemical compositions and occurrences by using SEM, TEM and XRD, and relative abundance of the identified mineral phases were estimated with the aid of XRD pattern simulation (NEWMOD software).

Two samples were studied; the standard soil (CJ-1) regarded as the origin of Asian dust (proposed by National Institute for Environmental Studies), and a dust collected on the ground on March 3, 2008 in Fukuoka, Kyushu, Japan. From powder XRD analyses, the constituent minerals of the CJ-1 and Fukuoka dusts are determined as 14, 10 and 7 angstrom clays, quartz, K-feldspar, plagioclase and amphiboles. Calcite peaks were only observed in CJ-1. XRD analyses of the oriented preparations with various treatments revealed that clay minerals in both samples are composed of smectite, vermiculite, chlorite, mica and kaolinite. XRD peaks of these clay minerals appear even in larger grain size fractions (2 - 20 micrometers), except for smectite. This suggests that small clay minerals either attach to the surface of larger particles or form aggregates. Occurrence of clay minerals (typically Fe-rich illite) coating the surface of quartz or feldspar grains was observed by SEM and TEM.

Chemical compositions of the clay minerals were estimated using TEM-EDS. Illite contains relatively high amount of Fe (around 0.5 atoms per O10(OH2) in average). The chemical composition of each clay mineral in the two samples is quite similar. Based on the determined chemical compositions, the volume ratio between illite, kaolinite chlorite and smectite in less than 2 micrometers fraction was estimated as about 5:2:1:1 by XRD pattern simulation.