東アジア大陸から日本への黄砂に伴う PAHs の長距離運搬—鉱物表面における PAHs の安定性—

Long Range Transport of PAHs with Aeolian Dusts from Eastern Asia Continent to Japan – Adsorption and Stability of PAHs on Mineral Surfaces -

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Polycyclic aromatic hydrocarbons (PAHs) are organic compounds originated by incomplete combustion of fossil fuel and released in the atmosphere in gas and aerosol phase. Because of their toxicity, environmental behavior of PAHs have attracted much attentions Long-range transport of PAHs has been known in various locations in the world for a long time already. However, such an issue have not been investigated from eastern Asian continent over Japan Sea even growing emissions are expected there by rapid industrial development.Anthropogenic sulfate and nitrate can accumulate on Asian dust particles during its transport in the atmosphere. Although there is a great probability that PAHs would adsorbed on dust particles, there is very little understanding on its nature and fate. In this study, aerosol particles have been collected from April 2003 for a year in the rural areas of Kanazawa, Ishikawa, JAPAN with the main objective of understanding the role of Asian dust in the atmospheric circulation of PAHs over long distances. Three sampling intervals have been designated in this study, namely: (1) Dust Period 1 (May 11 to 19, 2003); (2) Dust period 2 (May 28 to April 9, 2003); and (3) Dust period 3 (April 9 to 25, 2004). The Asian dust particles are dominantly in the coarse particle size range (2.1-11 μ m). The analyses for PAHs were performed separately in both coarse and fine particle range (<1.1 μ m). Seasonal trend of PAHs concentrations in coarse and fine particles showed Asian dust particles in Dust period 3 contained significant amount of less volatile PAHs such as Benzo[a]pyrene (BaP) and Benzo[g,h,i]perylene (BghiP). A kinetic model developed in this study revealed that these PAHs would be hardly accumulated on Asian dust particles in the atmosphere due to their extremely slow sorption rate. These PAHs would have to be originally PAHs-polluted soil particles. Back trajectory analyses would suggest that the Asian dust in Dust period 3 would have come from around the industrialized areas of the loess plateau. The stabilities of PAHs on mineral particles under controlled temperature and relative humidity (RH) with and without light irradiation were investigated. The aim was to understand the stability of PAHs associated with different components of Asian dust particles during transport over long distance. Pyrene (Pyr) was chosen as a model PAHs. Quartz showed a strong catalytic effect (i.e. enhances) in the decomposition of Pyr even with a coating of sorbed humic acid and without light irradiation (i.e. placed in the dark). Pyr sorbed on montmorillonite remained stable in the dark throughout the experimental period (3 day). Moisture in the experimental cell also decreased the stability of Pyr especially on α-alumina. Light irradiation decreased the stabilities of Pyr on quartz and montmorillonite, while the decomposition rate on montmorillonite was slower than on quartz in the dark. Photochemical degradation of Pyr on humic acid was not observed. PAHs sorbed on quartz and feldspar in Asian dust would be decomposed rapidly due to the catalytic role of silanol and aluminol sites on the mineral surface. The catalytic effect are enhanced further by light irradiation and elevated RH during transport over the Sea of Japan. Although a high RH and light irradiation could reduce PAHs stability on clay minerals, a considerable amount would still remain to last for several days. Humic acid in Asian dust particles would protect PAHs most efficiently from decomposition against high RH and light irradiation, but their influence would be minor due to their small amount in the Asian dust particles. The most realistic carrier of PAHs in the Asian dust over long distance would be clay minerals instead of humic acid. Geologic materials would play significant role for atmospheric circulation of PAHs than previously thought.