

Aggregation of colloidal montmorillonite and organic matter: Implications for the estuarine processes

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Colloidal dispersion and aggregation in rivers and estuaries were investigated in a laboratory system containing a clay mineral (i.e. montmorillonite), organic matter (i.e. humic acid), and artificial estuarine water. The salinity of the artificial estuarine water was varied between 0 and 7.2 psu to mimic the estuarine mixing processes. The colloids and aggregates were characterized for their size distributions and zeta potential.

The results indicate that the aggregation of colloidal suspensions that include humic acid does not follow the behavior predicted by the DLVO (Derjaguin and Landau, Verwey and Overbeek) theory, whereas the clay-only system follows the DLVO theory. For example, the DLVO theory-based calculations suggest the critical threshold salinity of this system to be 0.4 psu. However, the experiments show it to be between 3.6 and 7.2 psu.

The minimum net non-DLVO repulsive forces (i.e. primarily steric repulsion) for this system can be calculated by the surface interaction energy model that integrates the DLVO model calculations and experimental results. The magnitude of minimum steric repulsion is found to be in the same order as the van der Waals attraction.

This study shows that salinity cannot be used to model the aggregation behavior of riverine colloidal suspensions in systems that contain humic acid. These findings agree the aggregation behaviors observed in the Pearl River (i.e. humic acid-rich river) and Mississippi River (i.e. humic acid-poor). In addition, the surface interaction energy model can be used to estimate the magnitudes of steric repulsion in other systems containing other types of organic matter.

Chemical association of iron in individual atmospheric particles during Asian outflow season

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Using a single particle mass spectrometer (ATOFMS), size and chemical composition of ~2, 100, 000 individual atmospheric aerosol particles (D =100~1500 nm) were simultaneously observed on-line at the NIES Cape Hedo aerosol and atmospheric monitoring station in Okinawa Island, Japan (26.87°N, 128.26°E) during an Asian outflow season (March to April, 2008). On the basis of the mass spectrometric signature of Fe isotopic composition, Fe-containing aerosols were picked up and analyzed in detail. About 5~10% of observed aerosols was found to contain Fe, although the inclusion dropped to ~2% when oceanic air parcels (non-Asian outflow) arrived. The fraction of the Fe-containing aerosols was also size-dependent. Aerosols in the size range from 800~900 nm most frequently contained Fe (~15%). In addition to the dominant Fe-rich type, Fe found to be present in several aerosol chemical types. Potassium, Na, Al, organic carbon (OC), and sulfate were almost always associated with Fe. Phosphorus, Si, Li, Pb, and elemental carbon (EC) were also frequently associated with Fe, although different aerosol types had different amount of these elements and compounds, suggesting existence of multiple sources and/or atmospheric processes for the Fe-containing aerosols. Association of nitrate increased in large aerosols (D > 700 nm). The frequent association of Li implied strong influence of coal combustion aerosol sources on the Fe composition. A V-rich type exhibited quite different chemical association. The type contained Al, OC, EC and sulfate, but none of K, Na, P, Si, Li, and Pb. The unique association of the V-rich type suggested that combustion of low-grade fuel was also a source of Fe-containing aerosols. Further detailed chemical association during the Asian outflow will be discussed and compared with those over the North and South Pacific oceans observed using the same analytical technique.