Stability of suspended colloidal clays and organic matter in rivers

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The dispersion-aggregation behaviors of suspended colloids in rivers and estuaries are affected by the compositions of suspended materials (i.e., clay minerals vs. organic macromolecules) and salinity. Laboratory experiments were conducted to investigate the dispersion and aggregation mechanisms of suspended colloids under simulated river and estuarine conditions. The average hydrodynamic diameters of suspended particles (representing degree of aggregation) and zeta potential (representing the electrokinetic properties of suspended colloids and aggregates) were determined for systems containing suspended montmorillonite, humic acid, and/or chitin at the circumneutral pH over a range of salinity (0 – 7.2 psu). Similar experiments were conducted for natural whole water samples taken from Lower Mississippi River (Louisiana, USA) and Pearl River (Mississippi, USA).

The montmorillonite-only system increased the degree of aggregation with salinity increase, as would be expected for suspended colloids whose dispersion-aggregation behavior is largely controlled by the surface electrostatic properties and van der Waals forces. When montmorillonite is combined with humic acid or chitin, the aggregation of montmorillonite was effectively inhibited. The surface interaction energy model calculations reveal that the steric repulsion, rather than the increase in electronegativity, is the primary cause for the inhibition of aggregation by the addition of humic acid or chitin. Results from the natural whole water systems were in agreement with the laboratory systems. The organic matter-rich Pearl River colloid suspensions were relatively stable throughout the salinity range tested compared to the organic matter-poor Mississippi River colloids which were aggregated at a slight salinity increase.

These results help explain the range of dispersion-aggregation behaviors observed in natural river and estuarine systems. It is postulated that the composition of suspended particles, specifically the availability of steric polymers such as those contained in humic acid, determine whether the river suspension is rapidly aggregated and settled or remains dispersed in suspension and transported further upon discharge into the continental shelf when it encounters increasingly saline environments of estuaries and oceans.

Synthesis of organic molecules by ocean impacts on the early Earth

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Synthesis of prebiotic organic molecules on the early Earth must significantly influence to the Earth's environment and origin of life. Several models about the prebiotic syntheses have been proposed by previous researchers such as hydrothermal synthesis or delivery with carbonaceous chondrites. In this study, we propose a new hypothesis and demonstrate how our hypothesis is valid for the prebiotic organic syntheses. We hypothesized that impacts of iron-bearing meteorite on oceans synthesized organic molecules by reactions among meteoritic minerals, oceanic water, and atmospheric nitrogen. Impact experiments were performed using a singe-stage propellant gun. Samples are mixture of iron, nickel, carbon (^{13}C), water, and nitrogen. In particular, usage of ^{13}C is important to discriminate the possibility of contaminations. After the experiments water-extractable materials were recovered from the sample and analyzed with LC/MS and GC/MS. Four kinds of amines, six kinds of carboxylic acids and an amino acid (glycine) were detected in water-extractable portion of products. The above organic molecules were certainly composed of ^{13}C. These results suggest that the oceanic impact events can synthesize various organic molecules and these organic molecules could be a source of primitive life on the Earth. Present study further suggests that this impact event influenced on chemical compositions of the early atmosphere which are considered to be CO_2- and N_2-rich. Large amounts of atmospheric N_2 are easily converted to ammonia followed by the formation of large mass of organic molecules which have amino groups [1, 2]. Series of experiments also suggest that ocean impact events on the early Earth may contribute to solve a "nitrogen crisis" problem.

[1] Nakazawa *et al.* (2005) *Earth Planet. Scie. Lett.* **235**, 356-360. [2] Furukawa *et al.* (2009) *Nature Geoscience* **2**, 62-66.