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The interaction of illite colloid and Eu(III) under environmental conditions: Role of charge heterogeneity

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Radionuclides with high radiotoxicity and long half-life derived from nuclear industry activities would inevitably be introduced into the soil or groundwater. In order to propose a safe and efficient method to control the migration of radionuclides, it is of great significance to understand the environmental behavior of nuclides. The laboratory experiments and field studies have proven that colloids play a very important role for the transport of radionuclides in aquifer environment. Therefore, in this work, the typical environmental clay mineral colloid–illite colloid, was used to study the interaction between colloid and Eu(III) under environmental conditions.

The transport behaviors of illite colloid in saturated quartz sand column is completely dependent on the stability of the colloid. Illite colloid could complete breakthrough the quartz sand due to the high stability at high pH, low ionic strength and presence of HA, and the colloid could be blocked at low pH and high ionic strength; The transport behavior of Eu(III) is completely simultaneous with the colloids during the co-transport, that is, essentially depends on the stability of the colloid. Illite colloid faciliated the transport of Eu(III) under the conditions favorable to the stability of colloid, otherwise, the transport of Eu(III) was retained. Nevertheless, the retention of the colloid and Eu(III) was reversible, the blocked colloid and Eu(III) could be released and re-transported when the environmental chemical conditions became be favorable for the dispersion of the colloid.

However, the real environmental media is not the same as the ideal quartz sand media. Iron and aluminum oxides usually adhere on the media surface, resulting in nonuniform surface charge. The co-transport results of colloid and Eu(III) in the charge heterogeneous media show that the co-transport behavior of colloid and Eu(III) was consistent, that is, the transport behaviors of Eu(III) relyed on the transport behaviors of colloid. However, unlike pure quartz media, the transport of colloids in heterogeneous media were influenced by not only the dispersion stability of the colloid, but also the electrostatic attraction of colloids and media. Even the transport of stable colloids would be partially blocked, so the facilitation of colloid on Eu(III) transport was weaker than that in pure quartz sand. Moreover, due to the formation of additional colloid-iron oxide or colloid-Eu(III)-iron oxide, the co-transport of colloid and Eu(III) was more sensitive to changes in environmental chemical conditions. Therefore, it could be concluded that the influence of colloid on the transport of radionuclides was highly correlated on the stability of colloid and the interaction between colloid and media based on the above analysis. These findings could improve the understanding on the transport, retention and remobilization of environmental colloids and actinide nuclides, raising concerns about their potential transport risk to subsurface water, and provide theoretical guidance for the proposal of the control the transport of radionuclides in the environment.

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