Influence of initial concentrations and pH conditions on uranium adsorption in clays

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INTRODUCTION

- A specific geological background can lead to high concentrations of uranium (U) in the subsurface environment by mineral separation or elution.
- According to the results of a recent investigation by the Ministry of Environment, uranium was detected at a higher concentration than the maximum contaminant level for drinking water (MCL) in groundwater at South Korea.
- Primary removal mechanisms to purify radioactive uranium-contaminated water systems include adsorption, ion exchange, co-precipitation, reverse osmosis, and membrane filtration. However, in a general sense, the adsorption mechanism is the most used.
- The adsorption batch experiments were performed using three types of clay, and the removal efficiency of uranium according to the initial conditions and pH was investigated

MATERIAL AND METHODS

- Three types of clay (kaolinite, montmorillonite, and bentonite) were used on batch experiments.
- U solutions were prepared with a standard solution (1000 mg/L, Sigma Aldrich Atomic Absorption) at the concentration of 0 to 1 mg/L.
- The pHs of U solutions were adjusted to 4,7 and 9.5.
- Clays and U solutions were mixed in 10 g/L (solid /solution ratio).
- The supernatants were analyzed with ICP-MS after the suspensions were centrifuged.

▪ Data analysis

Removal efficiency : $R\ (\%) = \left(\frac{C_0 - C_e}{C_o}\right) \times 100$ (1)

Linear isotherm model : $C^* = K_d C_e$ (2)

Freundlich isotherm model : $C^* = K_F C_e^n$ (3)

R: percentage of adsorbed adsorbate from solution (%)

C_o: initial adsorbate concentration in solution (mg/L)

C^* : mass of solute sorbed per dry unit weight of solid (mg/kg)

K_d : distribution coefficient (L/kg)

K_F : Freundlich constanr

C_e:equilibrium adsorbate concentration in solution (mg/L)

CONCLUSION

The sorption performances were controlled by solution pH, initial uranium concentration. The U adsorption on montmorillonite and bentonite was well fitted to the Linear isotherm, and bentonite was well fitted with the Freundlich isotherm model. Consequently, montmorillonite and kaolinite can be used as an effective adsorbent in reducing the uranium from aqueous system.

RESULT

- Montmorillonite and kaolinite have shown the high uranium adsorption efficiencies of 99±0.4% at pH 9.5 and 96±3.8% at pH 7, respectively.
- The effect of pHs on adsorption efficiency was little observed at all initial concentrations in montmorillonite and kaolinite.
- Bentonite showed a low uranium adsorption efficiency of 68±23%, 69±30%, and 64±33.7% at pH 4, 7, and 9.5, respectively.
- The high adsorption efficiencies (>99%) were observed at less than 1 × 10-2 mg/L. However, the adsorption efficiencies were decreased by less than 50% at high initial concentration (< 0.5 mg/L).
- The linear isotherm model well described the results of montmorillonite and bentonite isotherm at solution concentration less than 1 mg/L.
- In case of bentonite, Freundlich isotherm model showed the best fit compared to linear isotherm model.

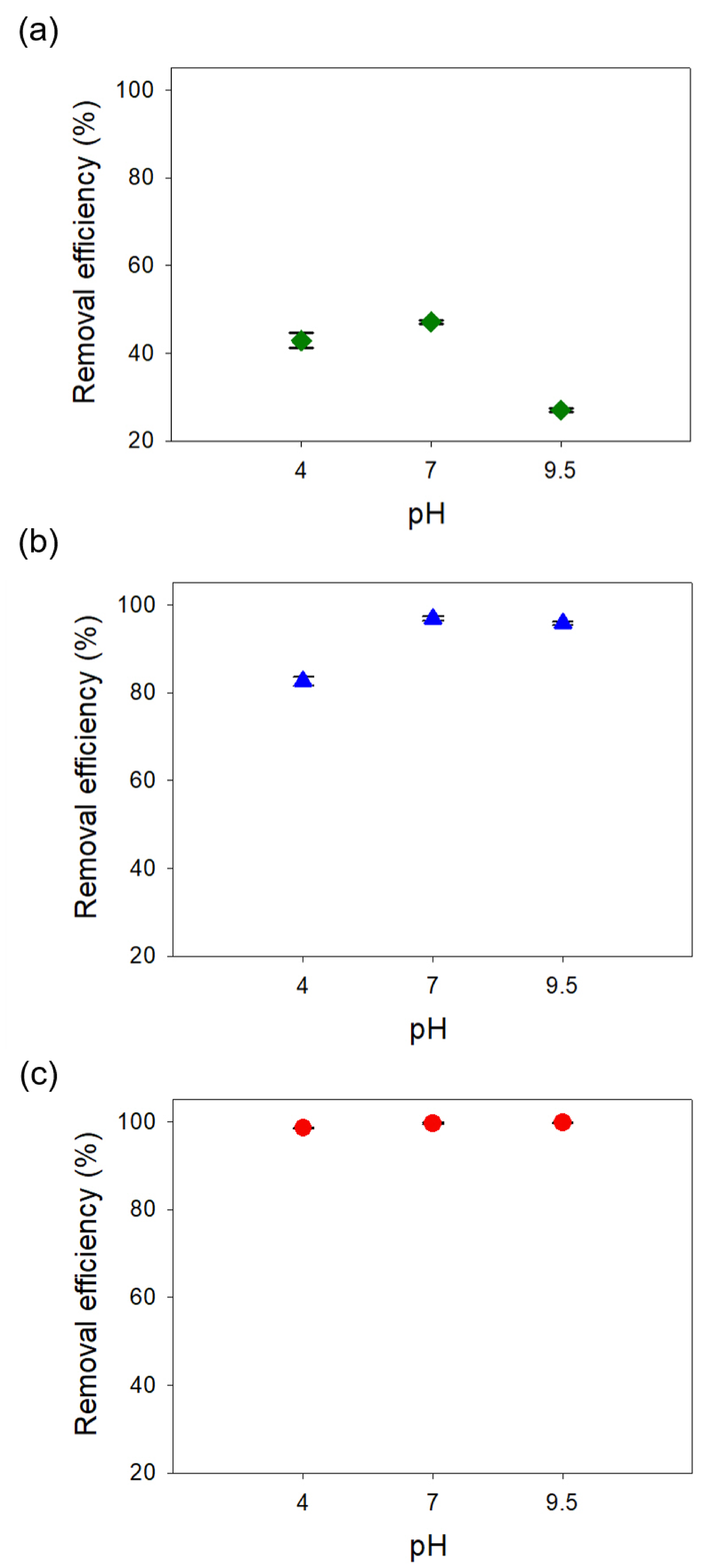

Fig. 1. U(VI) sorption onto (A) montmorillonite, (B) kaolinite and (C) bentonite as a function of pHs.

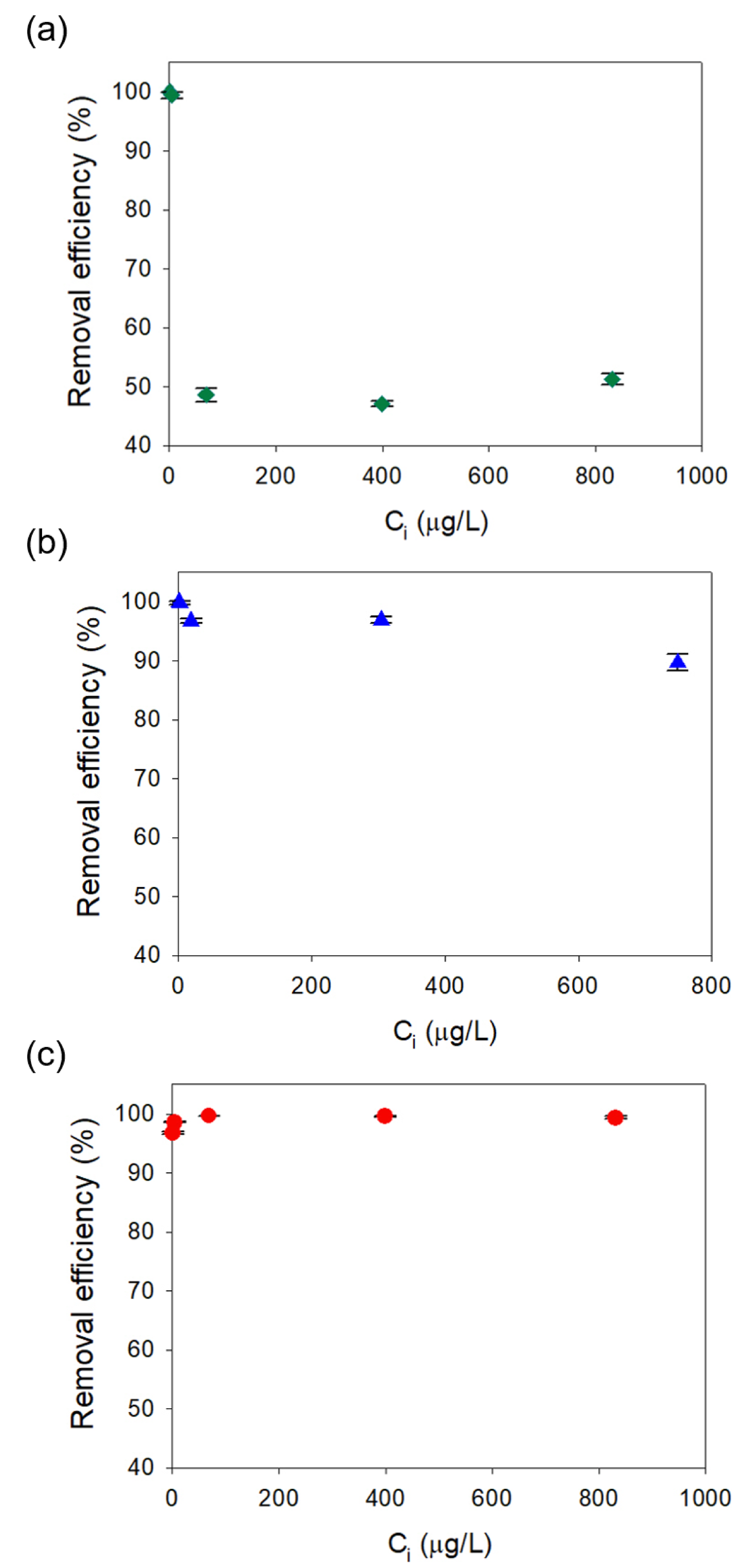

Fig. 2. U(VI) sorption onto (A) montmorillonite, (B) kaolinite and (C) bentonite as a function of initial uranium concentration.

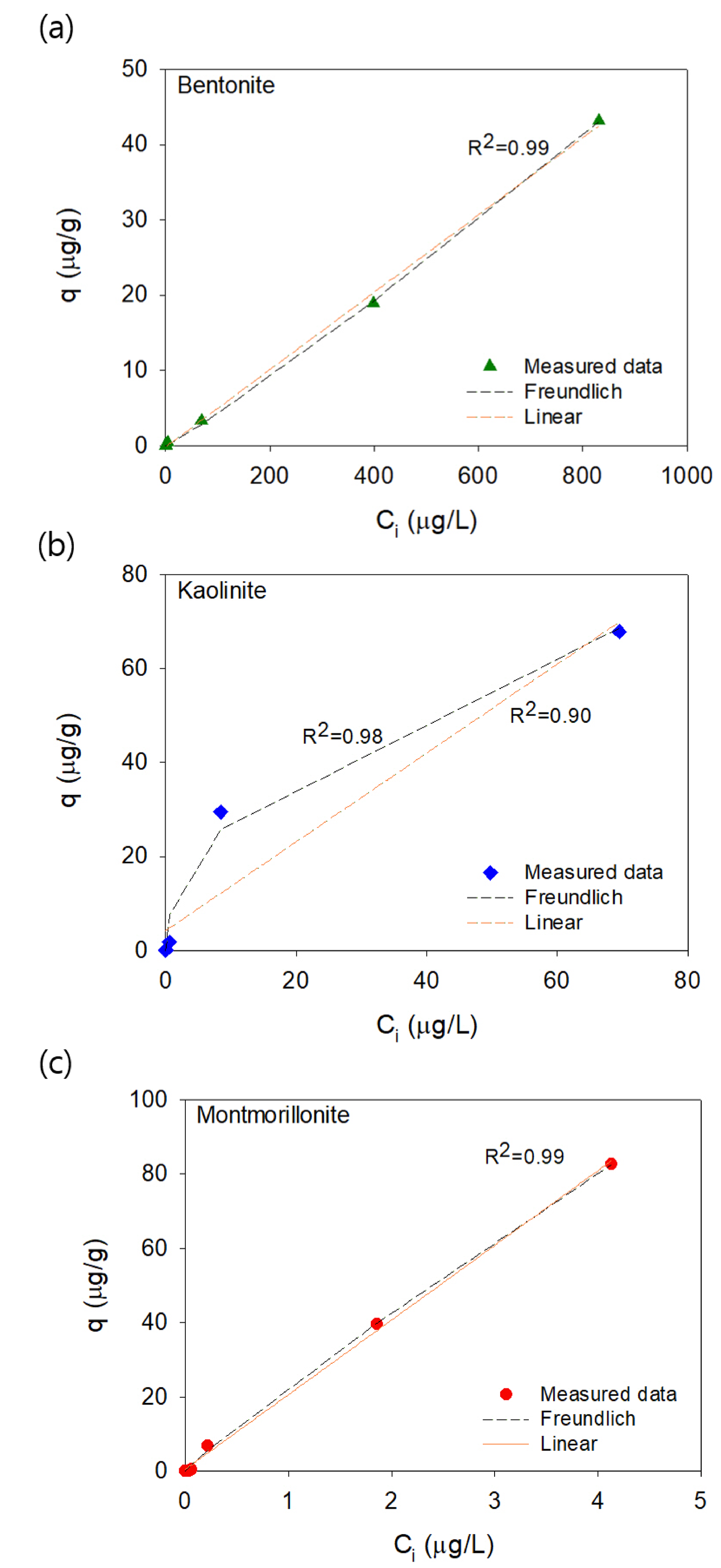

Fig. 3. Adsorption isotherms of uranium on bentonite, kaolinite, and montmorillonite.

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