Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supporting information

Significantly enhanced uptake of Eu^{3+} on a nanoporous zeolitic mineral in the presence of UO_2^{2+}: Insights into the impact of cation-cation interaction on the geochemical behavior of lanthanides and actinides

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Supporting information with 5 Pages, 1 table and 5 Figures.

More physicochemical characteristics of clinoptilolite used in the experiments, such as BET surface area, isoelectric point and stability of clinoptilolite at low pH, were measured actually. The specific surface area of clinoptilolite can't be measured by liquid nitrogen because of the "breathing motions" of zeolite lattices. The fluctuating sizes of ten-member-ring and eight-member-ring channels of clinoptilolite are too small for N_2 molecule to enter into due to weak vibrations of atoms at low temperature. At room temperature, N_2 molecule is able to enter into channels because of larger fluctuating size of clinoptilolite channels. Furthermore, we tried to measure the isoelectric point of clinoptilolite. It is shown that clinoptilolite exhibits a negative charge on surface and can maintain this character even at pH 2. This negative charge results from the substitution of Si^{4+} by Al^{3+} within the framework. This reveals that clinoptilolite has no isoelectric point in the pH range of 2-12, as we call this type of material "anionic framework" with cation-exchange capabilities. Furthermore, synthetic clinoptilolite have a very good stability at low pH value. The framework of synthetic clinoptilolite will remain stable in solution of HCl with a concentration of 1 M.

Eu and U L_{III}-edge EXAFS spectra were obtained at Shanghai Synchrotron Radiation Facility (SSRF, Shanghai, China) which is an advanced third generation light sources with high flux. The sample cell was enclosed in a self-made Ziploc bag, and Eu and U fluorescence response was measure with Lytle detector through which a constant flow of argon was maintained throughout the course of the experiments. Eu and U L_{III}-edge (Eu, 6976.9 eV; U, 17167 eV) EXAFS spectra were collected at 298 K with the measurement parameters which were shown in the table below.

Table S1. The parameters of EXAFS measurement.

Energy (eV)	-200 to -20	-20 to 30	30 to 150	150 to 300	300 to 450	450 to 600
Steps (eV)	1	0.5	1	2	3	4
Integral time (s)	5	5	5	5	5	5

"-" represents pre-edge; the positive represents post-edge

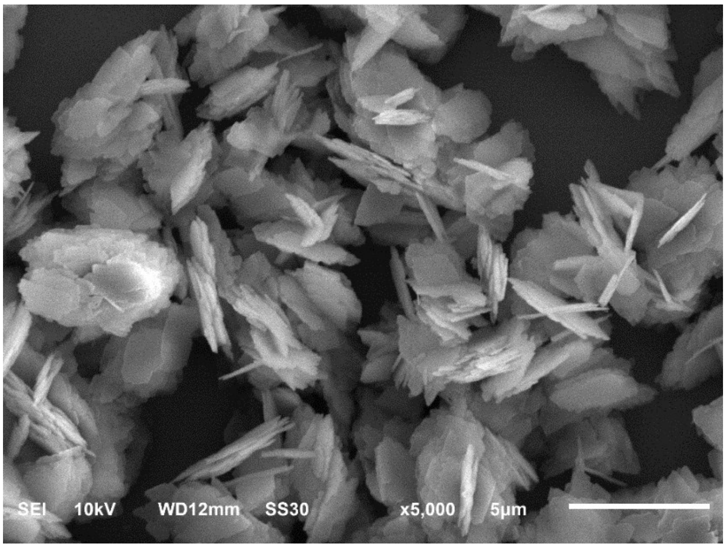

Fig. S1 The scanning electron microscopy(SEM) image of clinoptilolite.

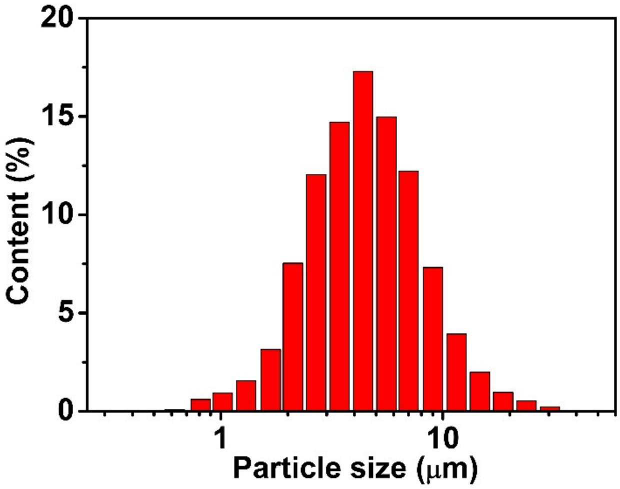

Fig. S2 The particle size of clinoptilolite.

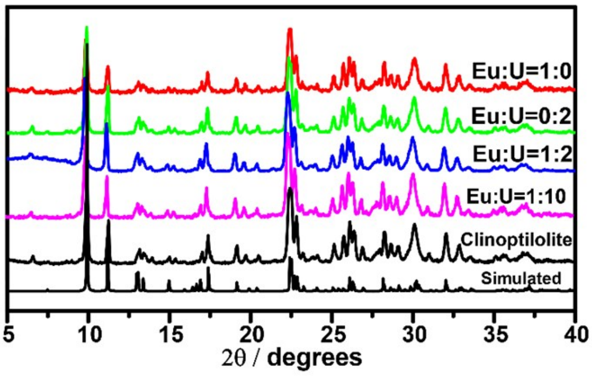

Fig. S3 Powder X-ray diffraction of clinoptilolite before and after adsorption.

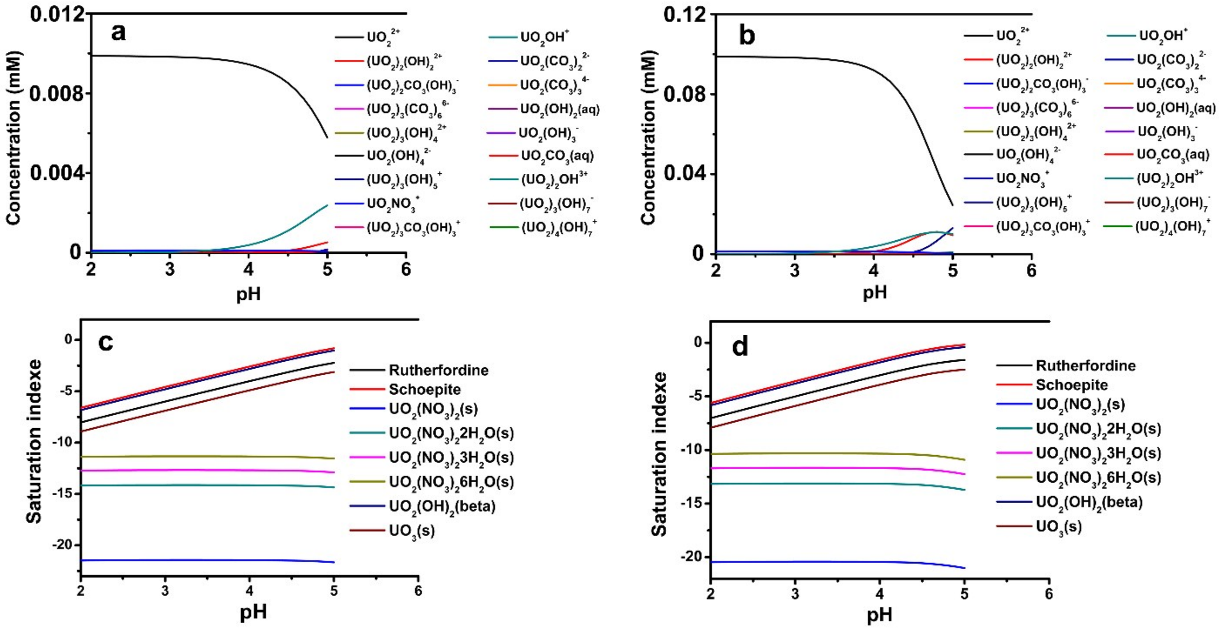

Fig. S4 Hydrolysis species (a, b) and saturation index (c, d) of potential precipitate phase in 0.01 mM (a, c) and 0.1 mM (b, d) UO_2^{2+} systems. The data were exported from software chemical equilibrium model of Visual MINTEQ 3.1. The parameters were imported according to experimental systems, such as Eu^{3+} and UO_2^{2+} concentrations, pH value, temperature, atmospheric condition, etc.

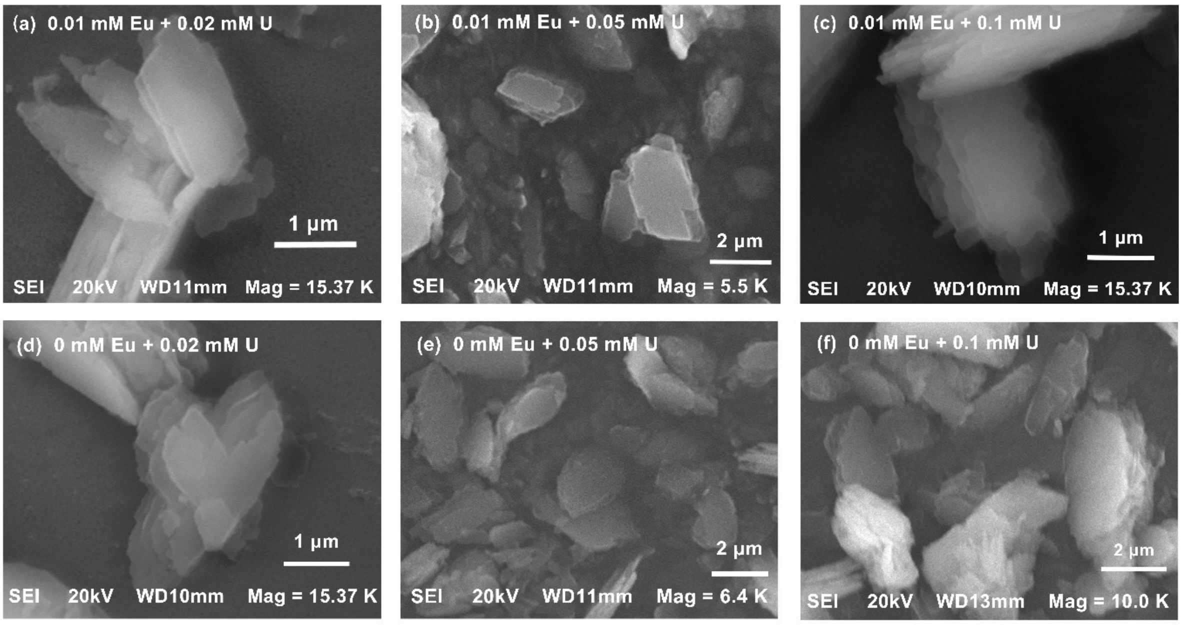

Fig. S5 Scanning electron microscope (SEM) images of clinoptilolite after loading UO_2^{2+} and Eu^{3+}.