Supplementary data

Supplementary Tables

Table S1. Weight of ore particle with each single grading for sample preparation of the column leaching experiments.

Particle size (mm)	Weight (g)						
	CG-S1	CG-S2	CG-S3	CG-S4	CG-S5	CG-S6	CG-S7
>5	34.93	33.09	31.25	29.41	27.57	25.74	23.90
−5~+2	100.03	94.76	89.50	84.23	78.97	73.71	68.44
−2~+1	40.52	38.39	36.25	34.12	31.99	29.86	27.72
−1~+0.5	53.11	50.32	47.52	44.73	41.93	39.14	36.34
−0.5~+0.25	34.47	32.65	30.84	29.02	27.21	25.40	23.58
−0.25~+0.075	21.95	20.79	19.64	18.48	17.33	16.17	15.02
<0.075	15.00	30.00	45.00	60.00	75.00	90.00	105.00
Total	300.00	300.00	300.00	300.00	300.00	300.00	300.00

Table S2. Weight of ore particle with each single grading for sample preparation of the height test of capillary rise.

Particle size (mm)	Weight (g)						
	CG-S1	CG-S2	CG-S3	CG-S4	CG-S5	CG-S6	CG-S7
>5	14.92	14.14	13.35	12.57	11.78	11.00	10.21
−5~+2	42.74	40.49	38.24	35.99	33.74	31.49	29.24
−2~+1	17.31	16.40	15.49	14.58	13.67	12.76	11.85
−1~+0.5	22.69	21.50	20.30	19.11	17.92	16.72	15.53
−0.5~+0.25	14.73	13.95	13.18	12.40	11.63	10.85	10.08
−0.25~+0.075	9.38	8.88	8.39	7.90	7.40	6.91	6.42
<0.075	6.41	12.82	19.23	25.64	32.05	38.45	44.86
Total	128.18	128.18	128.18	128.18	128.18	128.18	128.18

Table S3. Weight of ore particle with each single grading for sample preparation of the variable head permeability test.

Particle size (mm)	Weight (g)						
	CG-S1	CG-S2	CG-S3	CG-S4	CG-S5	CG-S6	CG-S7
>5	18.22	17.26	16.30	15.34	14.38	13.43	12.47
−5~+2	52.18	49.44	46.69	43.94	41.20	38.45	35.70
−2~+1	21.14	20.03	18.91	17.80	16.69	15.58	14.46
−1~+0.5	27.71	26.25	24.79	23.33	21.87	20.42	18.96
−0.5~+0.25	17.98	17.03	16.09	15.14	14.19	13.25	12.30
−0.25~+0.075	11.45	10.85	10.24	9.64	9.04	8.44	7.83
<0.075	7.83	15.65	23.48	31.30	39.13	46.95	54.78
Total	156.50	156.50	156.50	156.50	156.50	156.50	156.50

Table S4. Total content of ion-exchangeable phase rare earth in the rare earth ores with single particle size (expressed as oxides).

Sample	SG-S1	SG-S2	SG-S3	SG-S4	SG-S5	SG-S6	SG-S7
Particle size (mm)	>5	−5 to +2	−2 to +1	−1 to +0.5	−0.5 to +0.25	−0.25 to +0.075	<0.075
Ore grade (%)	0.0088	0.0227	0.0414	0.0547	0.0721	0.0893	0.1144

Supplementary Figures

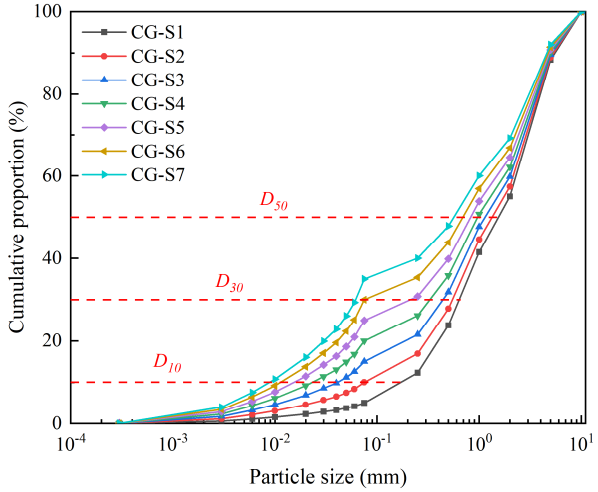

Figure S1. Particle size distribution curve of recombinant rare earth ores.

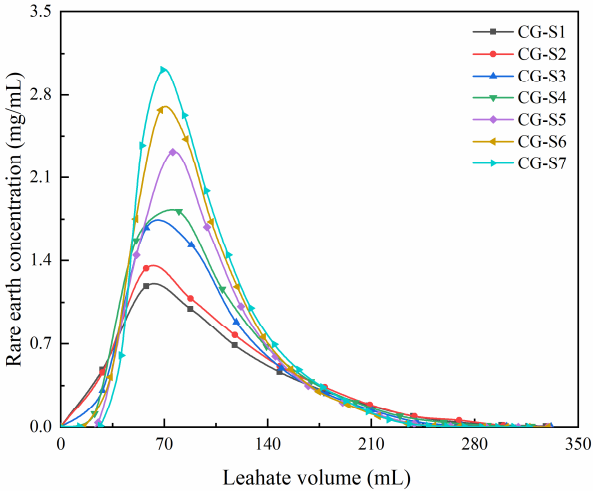

Figure S2. Rare earth concentration of samples with different fine particle contents.

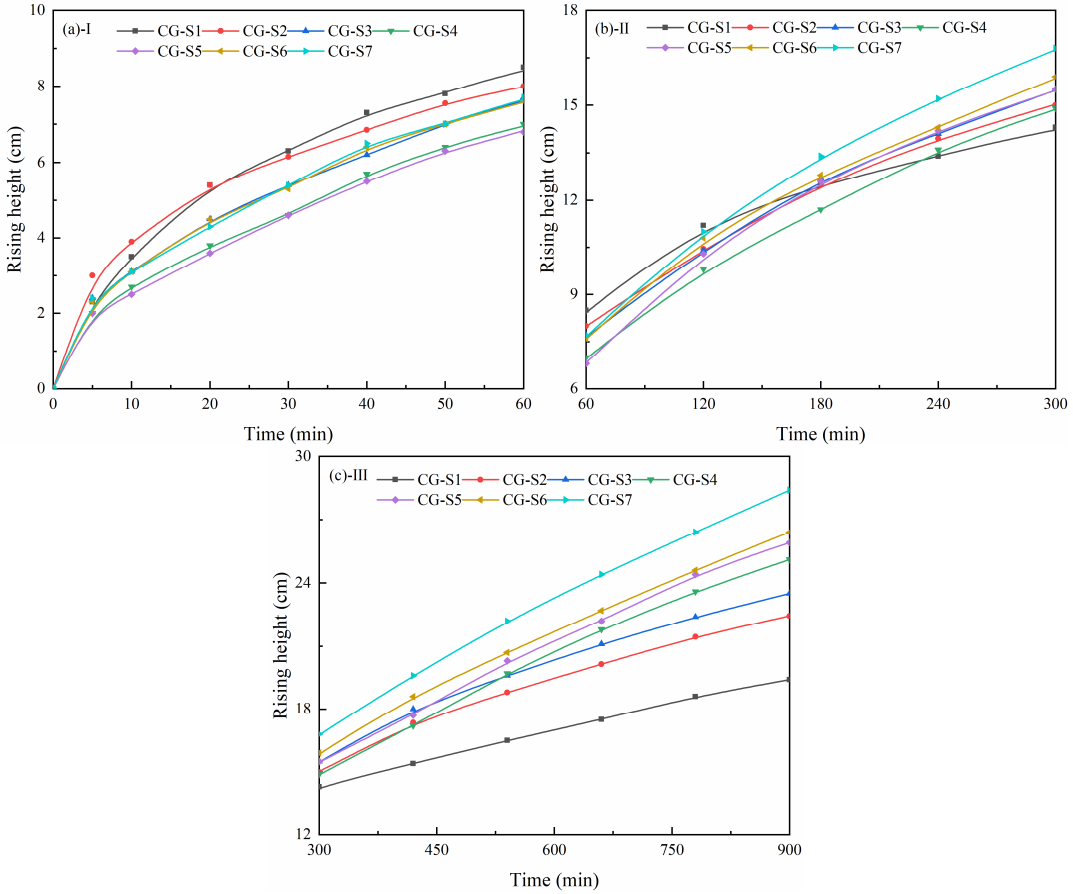

Figure S3. Rising height of capillary water over different time periods. (**a**) 0–60 min; (**b**) 60–300 min; (**c**) 300–900min.

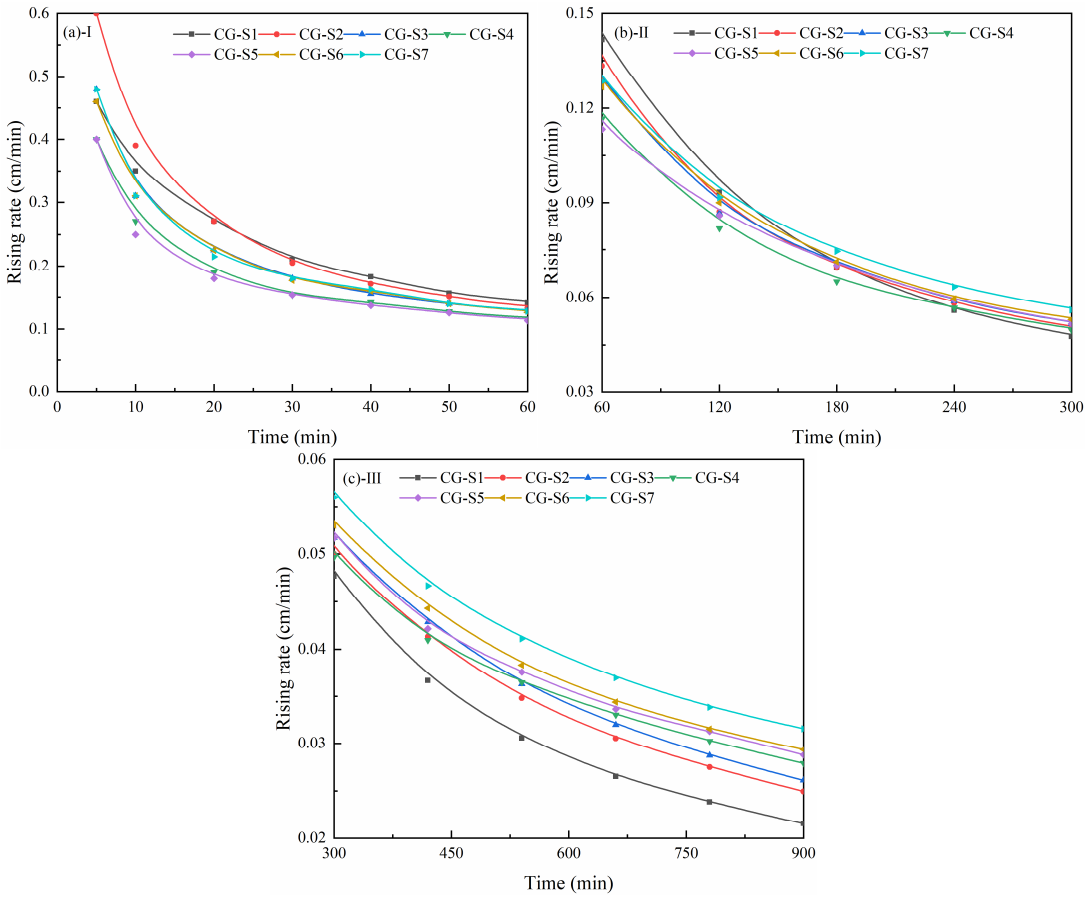

Figure S4. Rising rate of capillary water over different time periods. (**a**) 0–60 min; (**b**) 60–300 min; (**c**) 300–900min.