

**Supplementary Materials:****Table S1.** Mass balance of sulfuric acid baking-water leaching process.

Condition	Phase	wt%	%Elements							%Distribution						
			Ce	La	Nd	Y	Fe	Ca	P	Ce	La	Nd	Y	Fe	Ca	P
Feed	Solid	100.0	0.93	0.55	0.32	0.08	26.07	1.35	2.20	100	100	100	100	100	100	100
0.5 Acid/Solid 25 °C	Leachate	50.0	0.96	0.47	0.36	0.08	19.79	1.56	1.33	51.59	42.26	55.86	50.11	37.96	57.69	30.31
	Residue	50.0	0.90	0.64	0.28	0.08	32.35	1.14	3.07	48.41	57.74	44.14	49.89	62.04	42.31	69.69
1.0 Acid/Solid 25 °C	Leachate	56.2	1.32	0.74	0.46	0.11	30.56	1.41	2.37	79.97	75.33	79.97	75.33	65.88	58.81	60.60
	Residue	43.8	0.42	0.31	0.15	0.05	20.31	1.27	1.98	20.03	24.67	20.03	24.67	34.12	41.19	39.40
2.0 Acid/Solid 25 °C	Leachate	72.3	1.26	0.76	0.45	0.11	29.26	1.09	2.66	98.36	99.08	100.00	96.47	81.15	58.30	87.54
	Residue	27.7	0.05	0.02	0.00	0.01	17.74	2.04	0.99	1.64	0.92	0.00	3.53	18.85	41.70	12.46
2.0 Acid/Solid 50 °C	Leachate	74.4	1.19	0.70	0.43	0.10	27.27	0.91	2.59	95.63	94.20	100.00	92.74	77.81	49.93	87.42
	Residue	25.6	0.16	0.13	0.00	0.02	22.60	2.65	1.08	4.37	5.80	0.00	7.26	22.19	50.07	12.58
2.0 Acid/Solid 80 °C	Leachate	70.6	0.94	0.47	0.32	0.08	21.39	0.98	2.28	71.72	60.71	69.71	71.07	57.91	51.19	73.22
	Residue	29.4	0.89	0.74	0.33	0.08	37.33	2.25	2.00	28.28	39.29	30.29	28.93	42.09	48.81	26.78

**Table S1.** Mass balance of caustic digestion-acid leaching process

Process	Condition	Phase	wt%	%Elements							%Distribution						
				Ce	La	Nd	Y	Fe	Al	P	Ce	La	Nd	Y	Fe	Al	P
-	Feed	Solid	100.0	0.93	0.55	0.32	0.08	26.07	2.96	2.20	100	100	100	100	100	100	100
Caustic digestion	50 wt% NaOH	Solid	79.1	1.10	0.66	0.40	0.04	31.35	0.42	0.05	93.52	94.04	97.16	40.74	95.11	11.32	1.89
		Liquid	20.9	0.29	0.16	0.04	0.24	6.10	12.58	10.33	6.48	5.96	2.84	59.26	4.89	88.68	98.11
	40 wt% NaOH	Solid	79.8	1.10	0.68	0.39	0.06	31.19	0.85	0.45	94.35	98.42	97.89	58.25	95.46	22.87	16.42
		Liquid	20.2	0.26	0.04	0.03	0.17	5.86	11.32	9.11	5.65	1.58	2.11	41.75	4.54	77.13	83.58
	30 wt% NaOH	Solid	82.8	1.05	0.64	0.38	0.07	30.45	1.16	0.65	93.52	95.68	97.15	68.31	96.72	32.50	24.60
		Liquid	17.2	0.35	0.14	0.05	0.15	4.98	11.63	9.65	6.48	4.32	2.85	31.69	3.28	67.50	75.40
	20 wt% NaOH	Solid	91.5	0.92	0.58	0.33	0.06	26.79	2.63	0.81	90.42	96.28	95.01	68.17	94.02	81.12	33.55
		Liquid	8.5	1.04	0.24	0.19	0.31	18.34	6.58	17.21	9.58	3.72	4.99	31.83	5.98	18.88	66.45
Acid Leaching	50 wt% NaOH 3.0 M HCl	Leachate	58.0	1.22	0.89	0.54	0.06	35.09	0.58	0.00	74.51	91.44	97.16	38.38	78.06	11.32	0.00
		Residue	21.1	0.76	0.02	0.00	0.01	21.07	0.00	0.20	19.01	2.60	0.00	2.35	17.05	0.00	1.89
	40 wt% NaOH 3.0 M HCl	Leachate	56.1	1.43	0.97	0.56	0.08	34.84	0.86	0.21	86.54	98.42	97.89	54.21	74.96	16.23	5.39
		Residue	23.7	0.31	0.00	0.00	0.01	22.55	0.83	1.02	7.81	0.00	0.00	4.04	20.50	6.64	11.03
	30 wt% NaOH 3.0 M HCl	Leachate	54.8	1.57	0.96	0.57	0.10	36.94	1.66	0.47	92.62	95.68	97.15	68.31	77.65	30.77	11.73
		Residue	28.0	0.03	0.00	0.00	0.00	17.75	0.18	1.01	0.90	0.00	0.00	0.00	19.07	1.73	12.87
	20 wt% NaOH 3.0 M HCl	Leachate	60.5	1.04	0.78	0.46	0.08	30.14	3.15	0.98	68.22	85.65	85.76	58.34	69.94	64.20	27.05
		Residue	31.0	0.66	0.19	0.10	0.03	20.25	1.62	0.46	22.20	10.63	9.25	9.83	24.08	16.92	6.50
	50 wt% NaOH 2.0 M HCl	Leachate	48.1	1.34	1.08	0.65	0.05	35.14	0.70	0.00	70.65	82.30	89.35	37.17	64.82	10.85	0.00
		Residue	31.0	0.71	0.00	0.00	0.03	25.47	0.00	0.13	22.88	11.74	7.81	3.57	30.29	0.47	1.89
	50 wt% NaOH 1.0 M HCl	Leachate	30.4	0.37	1.46	0.84	0.08	21.49	1.10	0.00	11.40	75.02	74.31	26.22	25.06	11.32	0.00
		Residue	48.7	1.55	0.16	0.12	0.02	37.50	0.00	0.09	82.13	19.02	22.85	14.52	70.05	0.00	1.89