

SUPPLEMENTARY MATERIAL

Novel Extraction Route of Lithium from α -Spodumene by Dry Chlorination

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Table S1. Standard deviation on measured atomic percent of elemental composition of spodumene (Spot “1”) in leached residue.

Table S2. Standard deviation on measured atomic percent of elemental composition of calcium aluminosilicate (Spot “2”) in leached residue

Element	Atomic %										SD*
	Al	Si	Ca	O	Mg	Fe	Cl	Na			
Al	12.24	7.59	7.00	13.39	11.76	11.21	10.10	10.42	9.10	10.68	2.00
Si	17.57	23.18	19.34	16.97	17.21	19.22	21.33	20.71	18.94	20.46	1.97
Ca	7.33	4.64	11.21	7.14	8.60	5.98	5.03	5.18	8.24	5.28	2.07
O	61.81	62.54	60.91	61.72	61.27	62.42	63.12	62.33	60.78	62.87	0.81
Mg	0.28				0.16				0.28		0.07
Fe	0.45		0.34	0.29	0.30	0.79	0.14		0.50	0.36	0.19
Cl	0.32	1.75	1.20	0.24	0.70	0.38	0.13	1.15	2.16	0.14	0.72
Na		0.30		0.25			0.15	0.22		0.22	0.05

Table S3. Standard deviation on measured atomic percent of elemental composition of calcium silicate in leached residue.

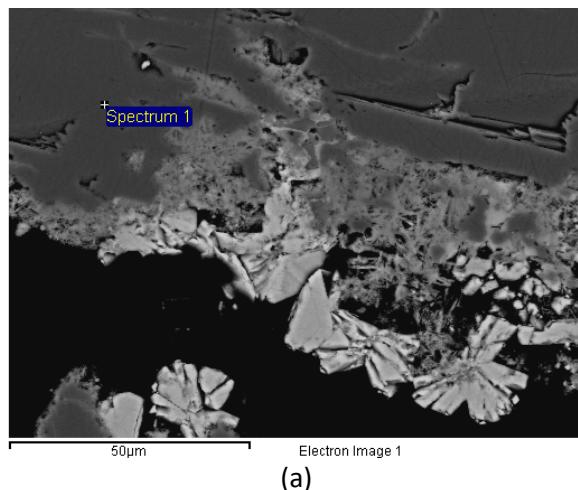
Table 33. Standard deviation on measured atomic percent of elemental composition of calcium silicate in leached residue.											
Element	Atomic %										SD*
Si	19.80	19.07	20.02	20.02	19.84	19.83	20.00	20.33	20.28	20.23	0.36
Ca	19.93	21.12	19.89	19.97	48.15	20.25	19.61	19.12	19.08	19.13	8.99
Cl	0.73	0.57	0.15								0.30
Mg							0.39	0.39	0.50	0.53	0.07
O	59.53	59.25	59.93	60.01	59.92	59.92	60.00	60.16	60.14	60.11	0.29

Table S4. Standard deviation on measured atomic percent of elemental composition of quartz in leached residue.

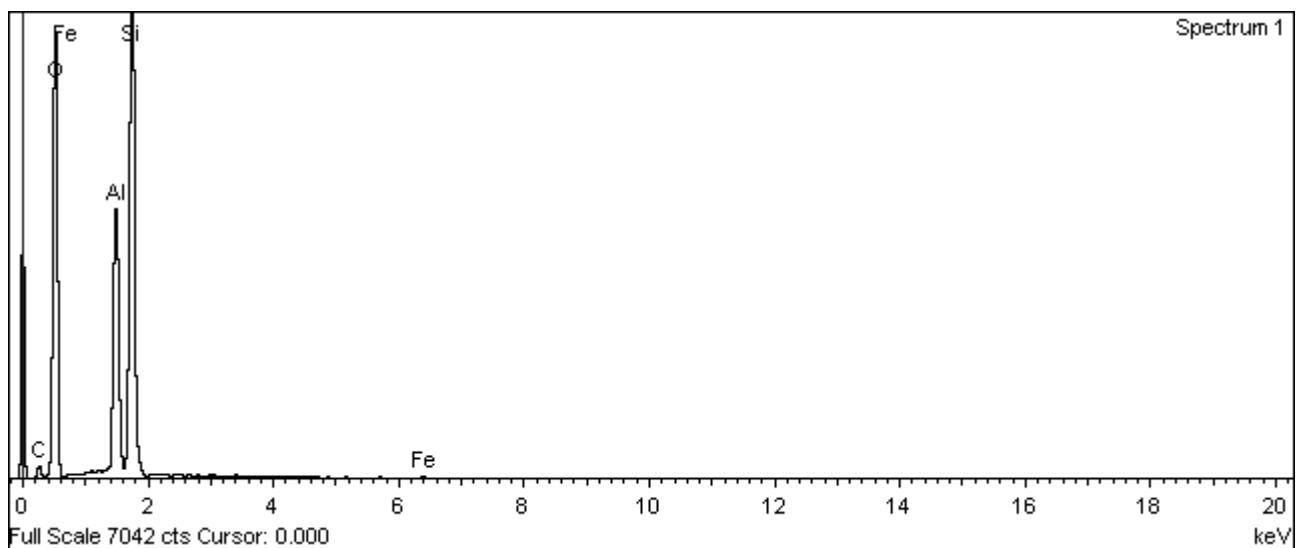
Table S5. Standard deviation on measured atomic percent of elemental composition of calcium aluminosilicate (Spot “2”) in leached residue.

Element	Atomic %					SD*
Al	6.99	5.60	4.46	4.39	5.91	1.08
Si	10.09	11.50	20.10	19.95	20.03	5.08
Ca	17.66	17.68	10.93	11.18	9.91	3.86
O	52.46	52.43	59.04	58.83	59.80	3.73
Mg	1.34	2.21	0.64	0.72	0.52	0.70
Fe	1.86	0.75	0.38	0.29	0.29	0.67
Cl	9.59	9.82	4.44	4.64	3.53	3.04

SD* represents the standard deviation on measured atomic percent of elements in mineral phases of chlorinated residue.



(a)

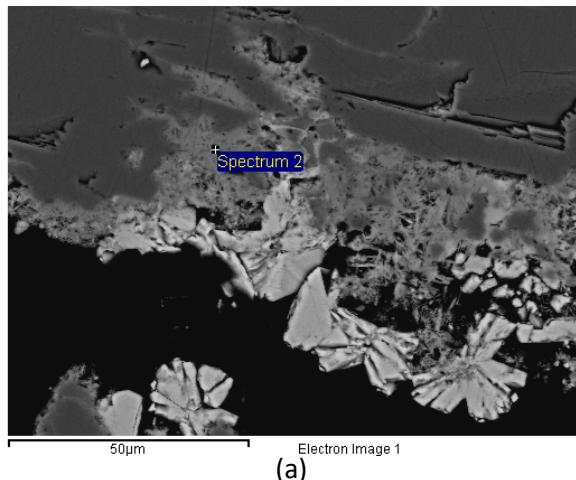


(b)

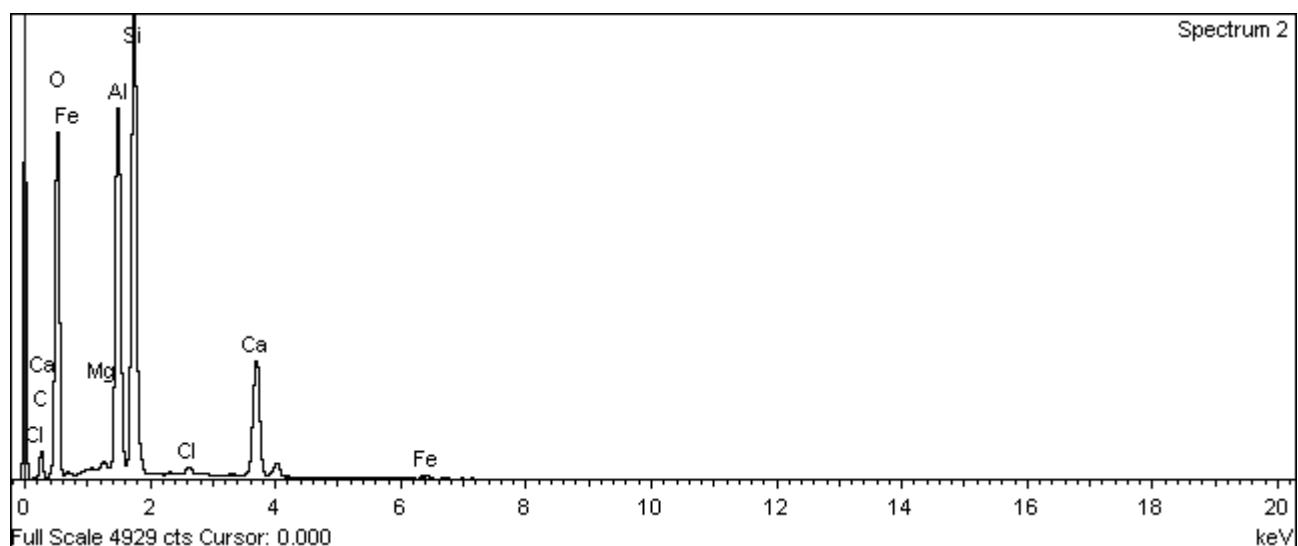
Figure S1: Spot analysis (a) and spectrum (b) of elemental composition of unaffected spodumene grain in chlorinated residue.

Table S6: Raw data of unaffected spodumene grain in chlorinated residue generated by SEM-EDS for spectrum 1.

Element	App Conc.	Intensity Corrn.	Weight% Sigma	Weight% Sigma	Atomic%	Compd%	Formula	Number of ions
Al K	15.57	1.0666	14.60	0.15	11.33	27.58	Al ₂ O ₃	1.40
Si K	29.99	0.9424	31.82	0.23	23.73	68.08	SiO ₂	2.93
Fe K	0.44	0.8737	0.50	0.13	0.19	0.72	Fe ₂ O ₃	0.02
O			49.46	0.29	64.75			8.00
Totals			96.38				Cation sum	4.36



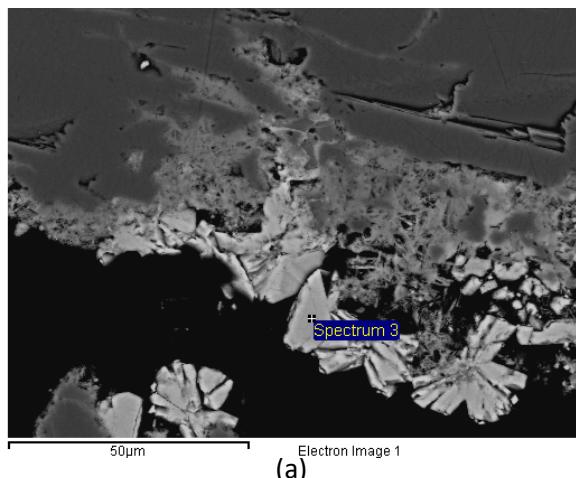
(a)



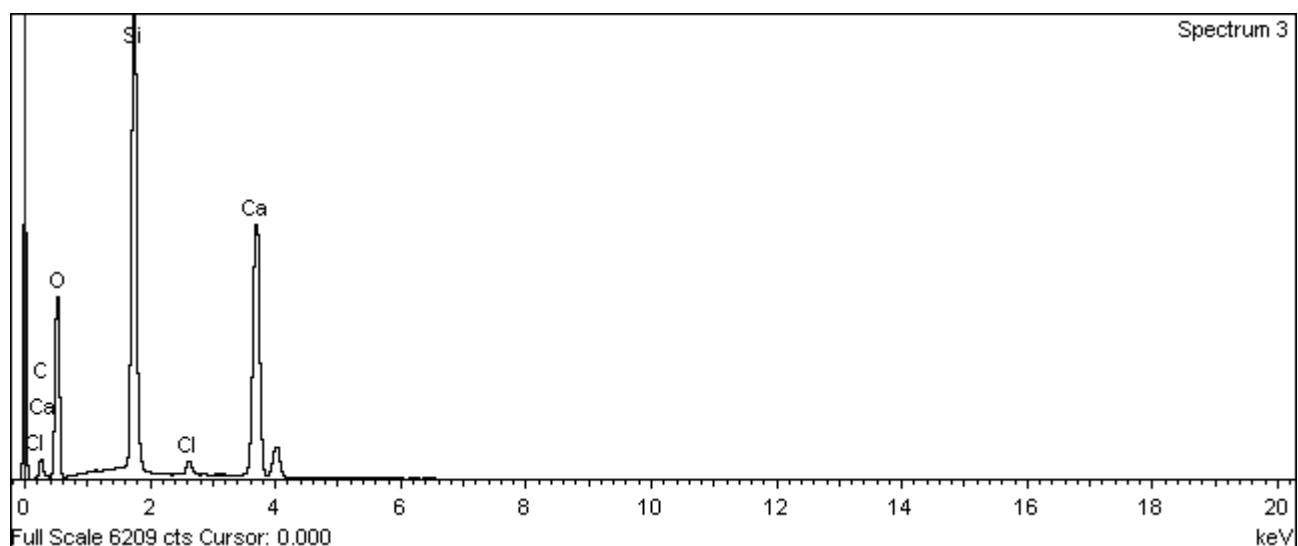
(b)

Figure S2: Spot analysis (a) and spectrum (b) of elemental composition of calcium aluminosilicate in chlorinated residue.**Table S7:** Raw data of calcium aluminosilicate in chlorinated residue.generated by SEM-EDS for spectrum 2.

Element	App Conc.	Intensity Corrn.	Weight% Sigma	Weight% Sigma	Atomic%	Compnd%	Formula	Number of ions
Mg K	0.30	0.9735	0.31	0.05	0.28	0.51	MgO	0.04
Al K	15.20	1.0317	14.74	0.15	12.24	27.85	Al ₂ O ₃	1.58
Si K	20.44	0.9283	22.02	0.19	17.57	47.10	SiO ₂	2.26
Cl K	0.38	0.7624	0.50	0.07	0.32	0.00		0.04
Ca K	12.75	0.9721	13.11	0.19	7.33	18.35	CaO	0.94
Fe K	0.99	0.8785	1.13	0.16	0.45	1.61	Fe ₂ O ₃	0.06
O			44.11	0.30	61.80			7.96
Totals			95.91			Cation sum	4.88	



(a)

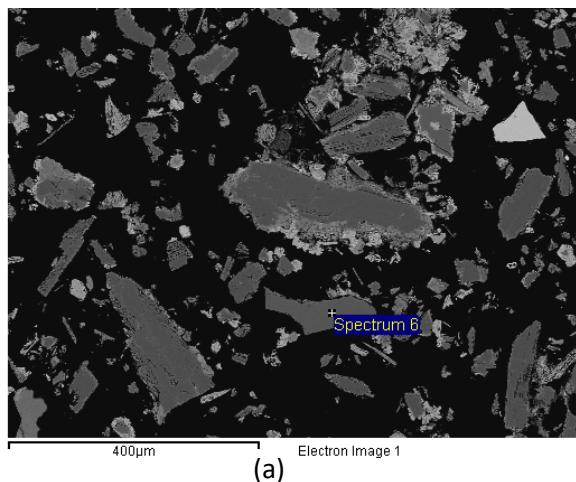


(b)

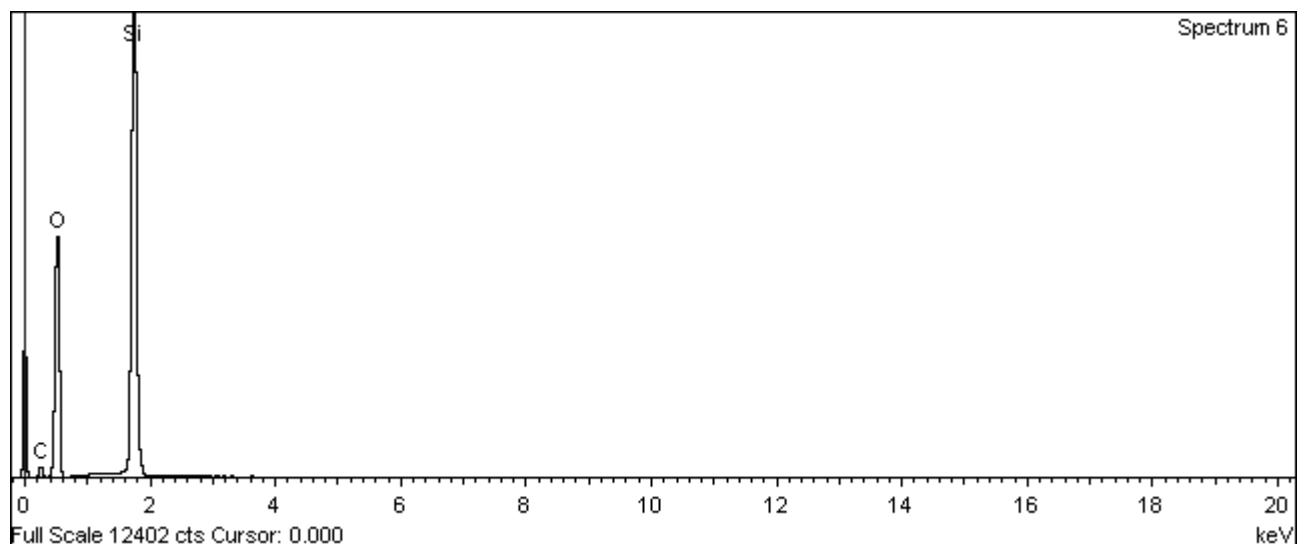
Figure S3: Spot analysis (a) and spectrum (b) of elemental composition of calcium silicate in chlorinated residue.

Table S8: Raw data of calcium silicate in chlorinated residue generated by SEM-EDS for spectrum 3.

Element	App Conc.	Intensity Corrn.	Weight% Sigma	Weight% Sigma	Atomic%	Compnd%	Formula	Number of ions
Si K	26.05	1.0545	24.70	0.19	19.80	52.84	SiO ₂	2.63
Cl K	0.94	0.8109	1.15	0.08	0.73	0.00		0.10
Ca K	35.40	0.9977	35.48	0.29	19.93	49.64	CaO	2.65
O			42.30	0.27	59.53			7.90
Totals			103.63				Cation sum	5.27



(a)

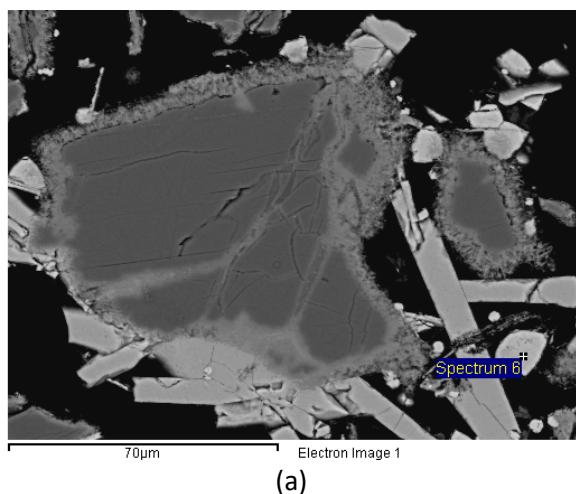


(b)

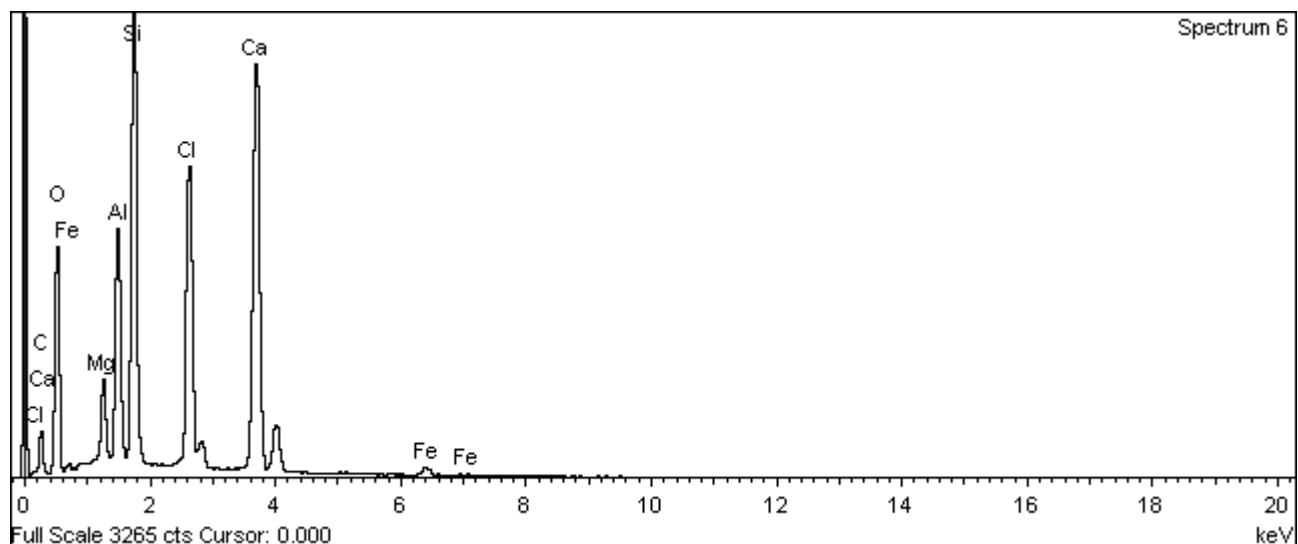
Figure S4: Spot analysis (a) and spectrum (b) of elemental composition of quartz grain in chlorinated residue.

Table S9: Raw data of quartz grain in chlorinated residue generated by SEM-EDS for spectrum 6.

Element	App Conc.	Intensity Corrn.	Weight% Sigma	Weight% Sigma	Atomic%	Compnd%	Formula	Number of ions
Si K	52.70	1.0841	48.61	0.26	33.33	103.99	SiO ₂	4.00
O			55.38	0.27	66.67			8.00
Totals			103.99				Cation sum	4.00



(a)



(b)

Figure S5: Spot analysis (a) and spectrum (b) of elemental composition of calcium aluminosilicate chloride in chlorinated residue.

Table S10: Raw data of calcium aluminosilicate chloride in chlorinated residue generated by SEM-EDS for spectrum 6.

Element	App	Intensity	Weight %	Weight %	Atomic %	Compd %	Formula	Number of ions
	Conc.	Corrn.			Sigma			
Na K	2.26	0.9627	2.35	0.10	2.11	3.17	Na ₂ O	0.26
Al K	11.45	1.0478	10.92	0.13	8.36	20.64	Al ₂ O ₃	1.04
Si K	33.27	0.9663	34.43	0.23	25.31	73.66	SiO ₂	3.15
O			49.76	0.28	64.22			8.00
Totals			97.47				Cation sum	4.46