Supplementary Information

Rapid Recognition and Quantitative Technique of Niobium Minerals by Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy

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Table S1 Optimum conditions of rapid recognition experiments based on EDS

Resolution	Single filed magnification	Min grain size	Step pixels	Image dwell time(us)	Second image dwell (us)	Fast EDS acquisition time (s)	Total time(min)
4096	□60	5	96	5	0	0.10	113
4096	□60	5	96	5	0	0.07	96
4096	□60	5	96	5	0	0.05	94
4096	□60	5	96	5	0	0.03	88
4096	□60	5	96	5	0	0.01	84
1024	×60	5	6	5	0	0.10	73
2048	×60	5	24	5	0	0.10	58
8192	×60	5	384	5	0	0.10	262
1024	×120	5	24	5	0	0.10	87
2048	×120	5	96	5	0	0.10	100
2048	×60	5	24	5	0	0.03	41
2048	×60	5	24	3	0	0.03	37
2048	×60	5	24	1	0	0.03	33
2048	×60	5	24	1	2	0.03	34
2048	×60	5	24	1	3	0.03	35
2048	×60	5	24	1	5	0.03	37
4096	×60	3	34	1	3	0.03	99
2048	×120	3	34	1	3	0.03	101
2048	×60	7	45	1	3	0.03	24
1024	×60	7	11	1	3	0.03	25
4096	×60	7	180	1	3	0.03	46
4096	×60	10	368	1	3	0.03	35
2048	×60	10	92	1	3	0.03	16
1024	×60	10	23	1	3	0.03	15
1024	×60	15	52	1	3	0.03	8
2048	×60	15	52	1	3	0.03	13

Table S2 EDS results and reference values for standards

□Standards	Oxides	EDS results	Reference	SD
□	SrO	13.01	13.15	0.07
□$Sr_{0.5}Ba_{0.5}Nb_2O_6$	BaO	19.55	19.47	0.09
□	Nb_2O_5	67.57	67.94	0.26
□$KNbO_3$	K_2O	25.74	25.89	0.11
□	Nb_2O_5	75.23	74.10	0.43

Table S3 EDS results and EPMA values for niobium minerals at the same locations of the slice sample

	□	F	Na_2O	CaO	TiO_2	Nb_2O_5	Ce_2O_3	Nd_2O_3	FeO	SrO	BaO	SiO_2	Eu_2O_3	Y_2O_3
Pyrochlore	EDS	4.36	6.89	12.30	4.56	63.91	4.04	2.29	1.02	0.16	0.47	-	-	-
	EPMA	4.67	7.21	12.14	4.59	63.91	3.75	2.88	0.48	0.30	0.07	-	-	-
Aeschynite	EDS	-	-	7.00	16.56	39.06	2.35	5.64	4.09	-	-	4.97	0.70	2.84
	EMPA	-	-	6.84	16.67	39.11	2.02	5.62	3.73	-	-	4.97	0.89	2.48

Table S4 Quantitative analysis error requirement of SEM-EDS (GBT 25189-2010)

Weight%	Accepted RDEV/%	
	alloys	minerals
wt%＞20%	2	5
3%≤*wt*% ≤20%	5	10
0.5%≤*wt*% ≤1%	15	20
0.5%≤*wt*% ≤1%	20	30
0.1%≤*wt*% ≤0.5%	30	50

Table S5 The eigenvalue and variance using PCA method based on the composition data of niobium minerals

PC	Eigenvalue	% variance
1	163.945	76.1090
2	27.5879	12.8070
3	10.1021	4.68980
4	4.52476	2.10060
5	3.41765	1.58660
6	1.69288	0.78590
7	0.94468	0.43856
8	0.70903	0.32916
9	0.65381	0.30352
10	0.39697	0.18429
11	0.34289	0.15918
12	0.25426	0.11804
13	0.22593	0.10489
14	0.20398	0.09470
15	0.12457	0.05783
16	0.10470	0.04861
17	0.06159	0.02859
18	0.04492	0.02086
19	0.03882	0.01802
20	0.02987	0.01387
21	0.00079	0.00037

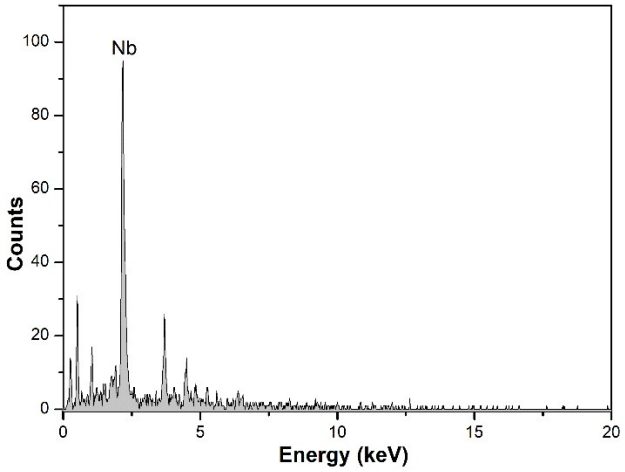

Figure S1 The EDS spectrum of Nb-mineral obtained at the time of 0.03s