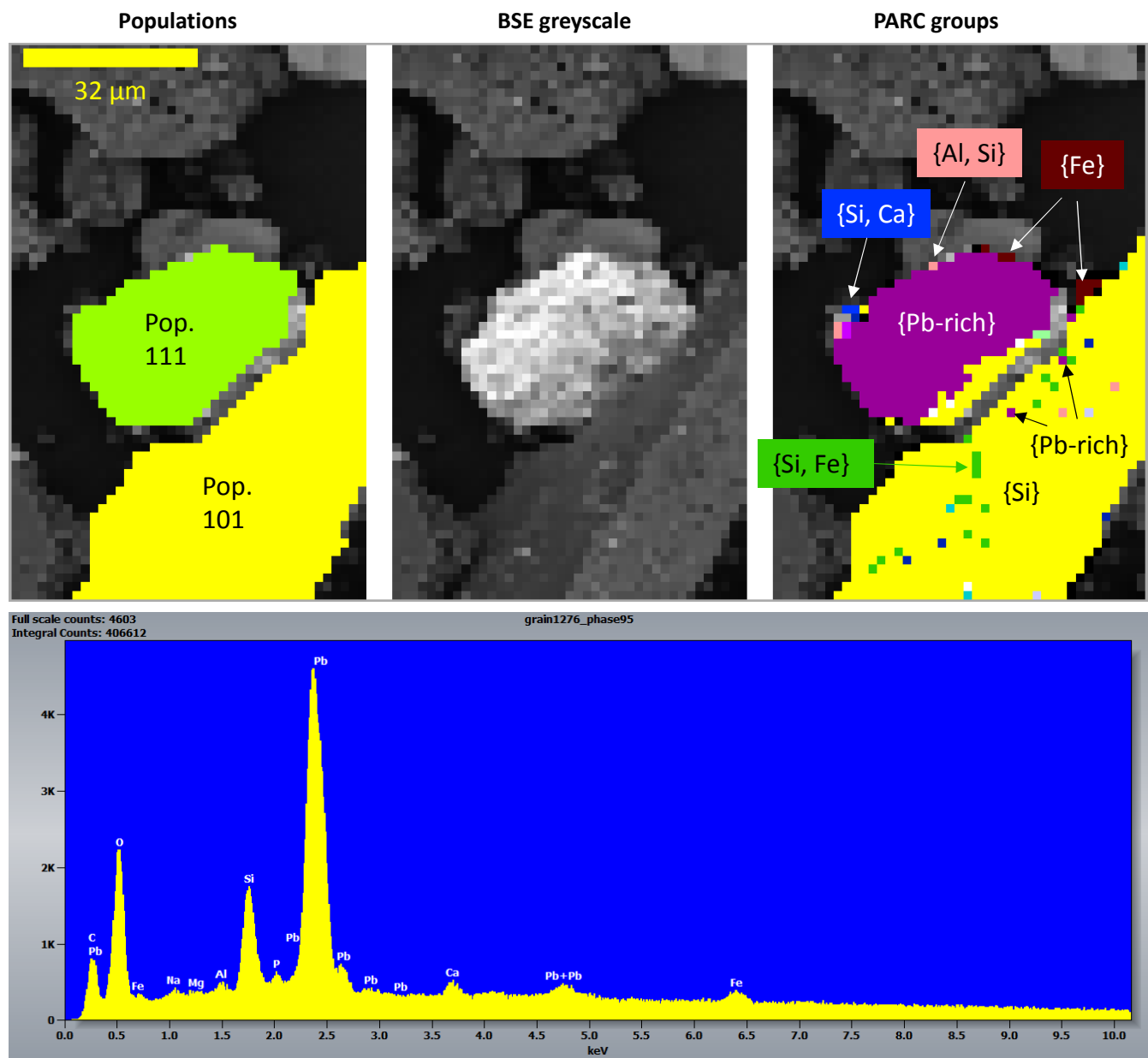


Supplementary information S13

S13: Primary PARC imagery of example grains referred to in main text, showing grain population image, SEM-BSE image (greyscale) and PARC group image (phase map). Labels refer to PARC groups explained in supplementary file S2A. Quantitative analyses shown in S13D are for PARC groups from phase model B (S2B), where selected phases have been merged for purposes of quantifying chemistry. S13A-C show quantitative analyses of the sum-spectra from the {Pb-rich} group for each grain, together with their corresponding raw spectra.

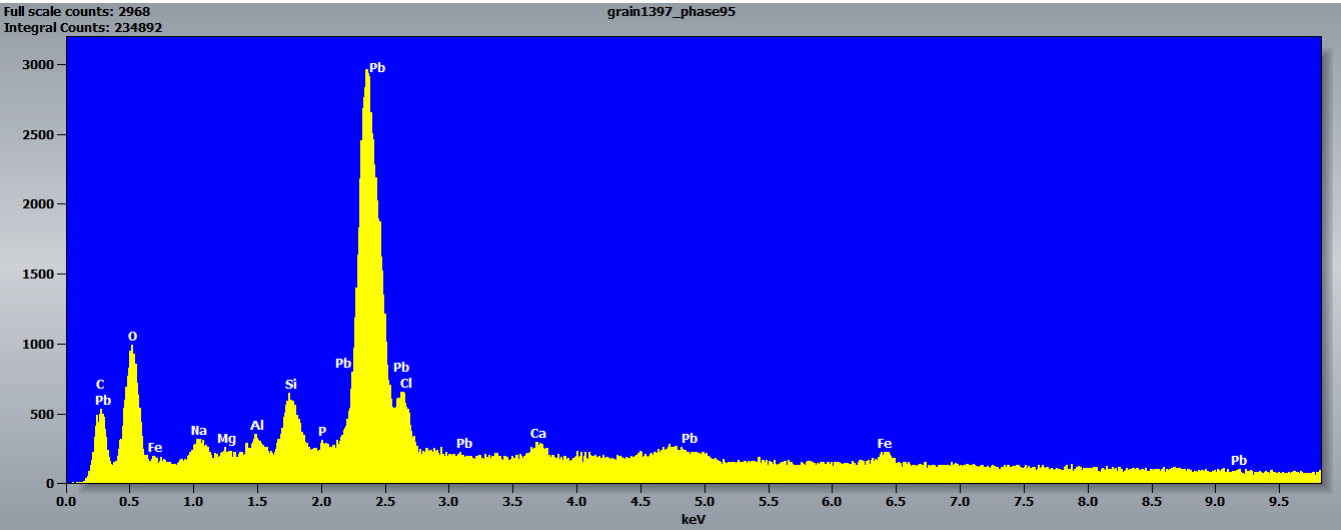
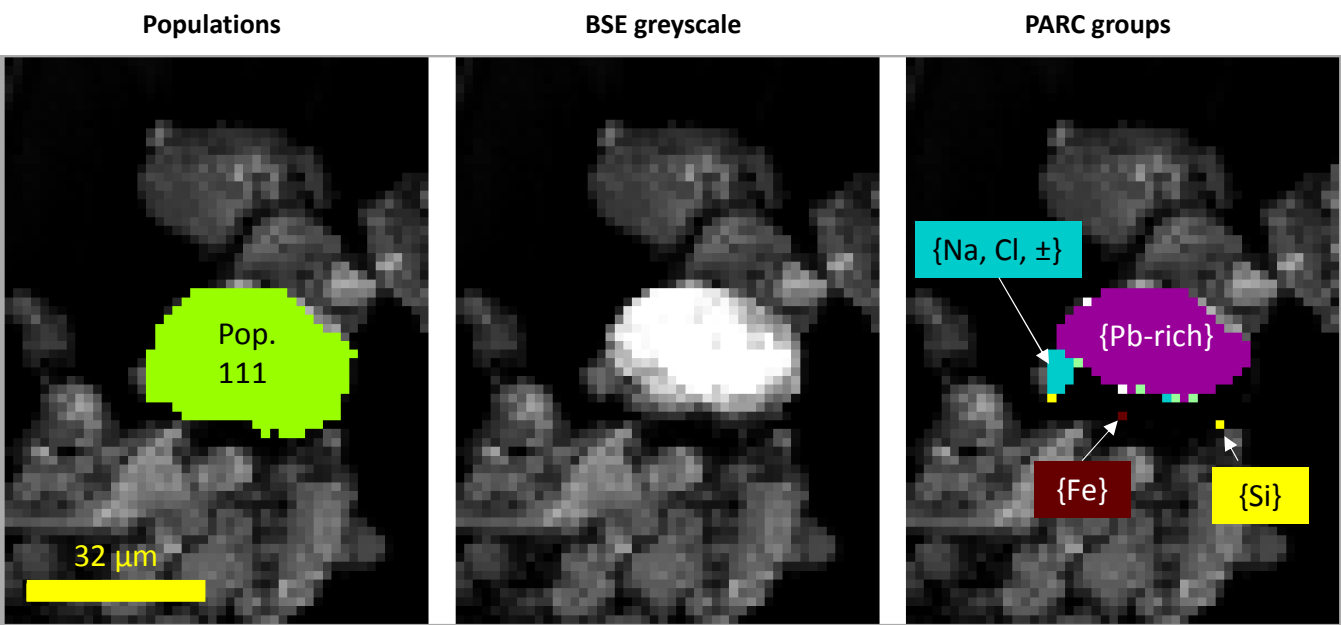
S13A



Sum spectrum analysis (i) {Pb-rich} group in grain: 300 pixels

grain 1276			
Net Counts		Compound %	
C	6020	CO2	0.00
O	6747	(null)	0.00
Na	586	Na2O	0.52
Mg	295	MgO	0.24
Al	575	Al2O3	0.45
Si	12748	SiO2	10.42
P	1887	P2O5	1.55
S	0	SO3	0.00
Cl	1408	Cl	0.87
K	441	K2O	0.35
Ca	2395	CaO	2.35
Ti	0	TiO2	0.00
V	0	V2O5	0.00
Cr	362	Cr2O3	0.64
Mn	0	MnO	0.00
Fe	2506	FeO	5.45
Zn	0	ZnO	0.00
Ba	0	BaO	0.00
Pb	100403	PbO	77.15

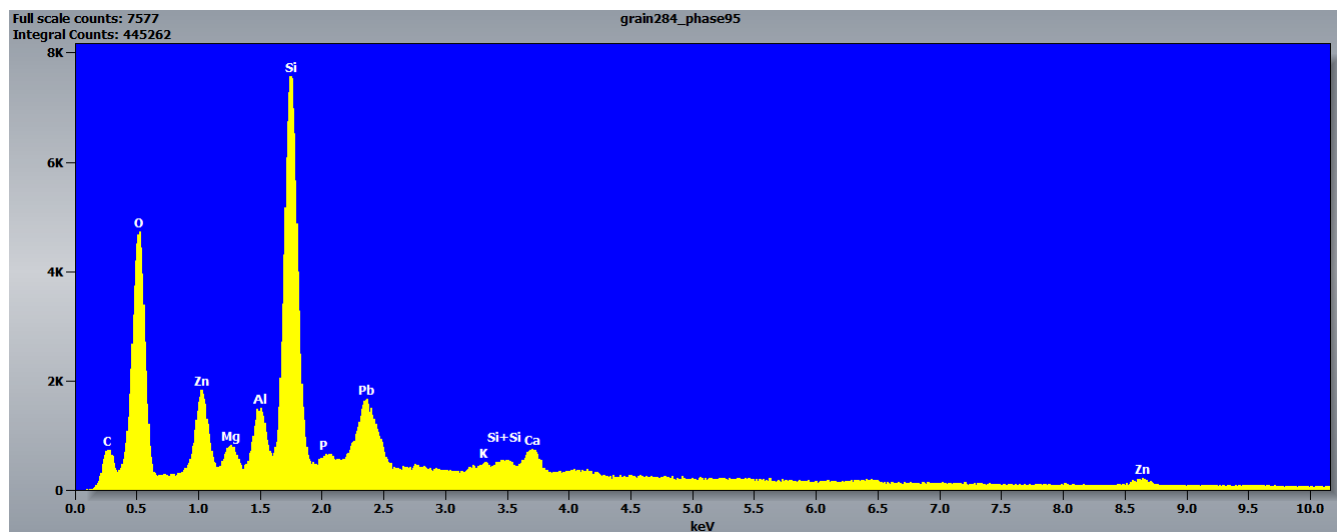
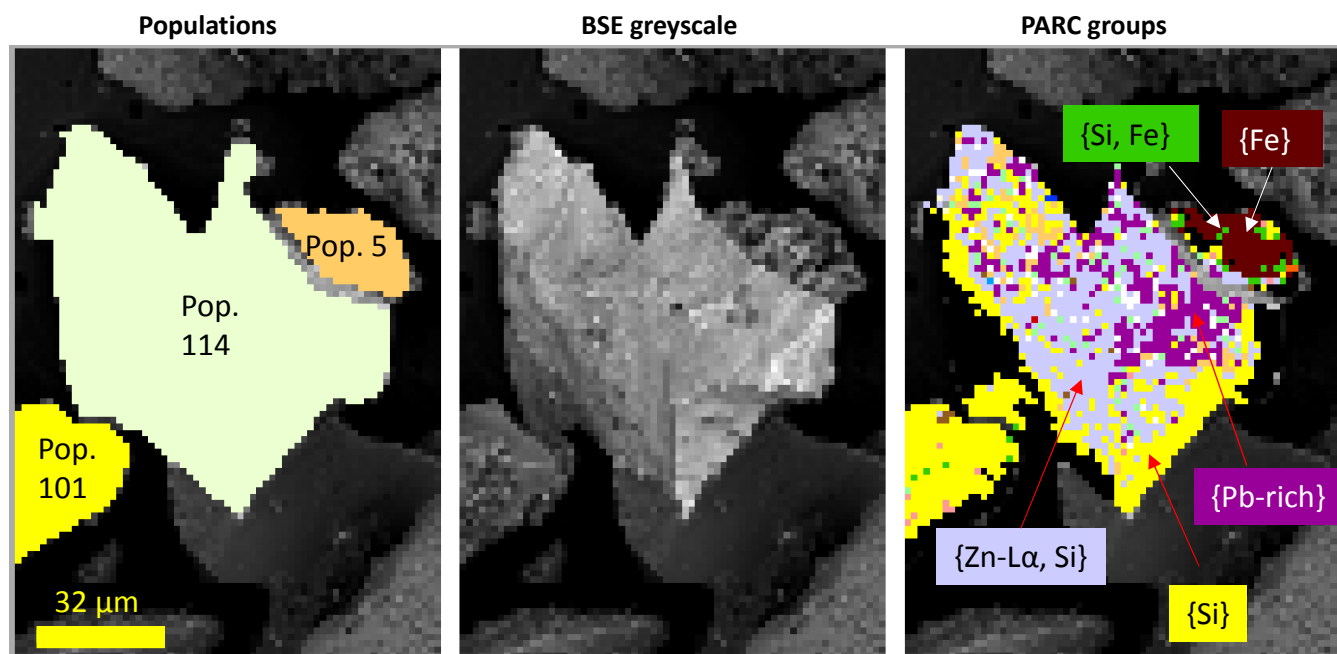
(ii)



Sum spectrum analysis
{Pb-rich} group in grain:
189 pixels

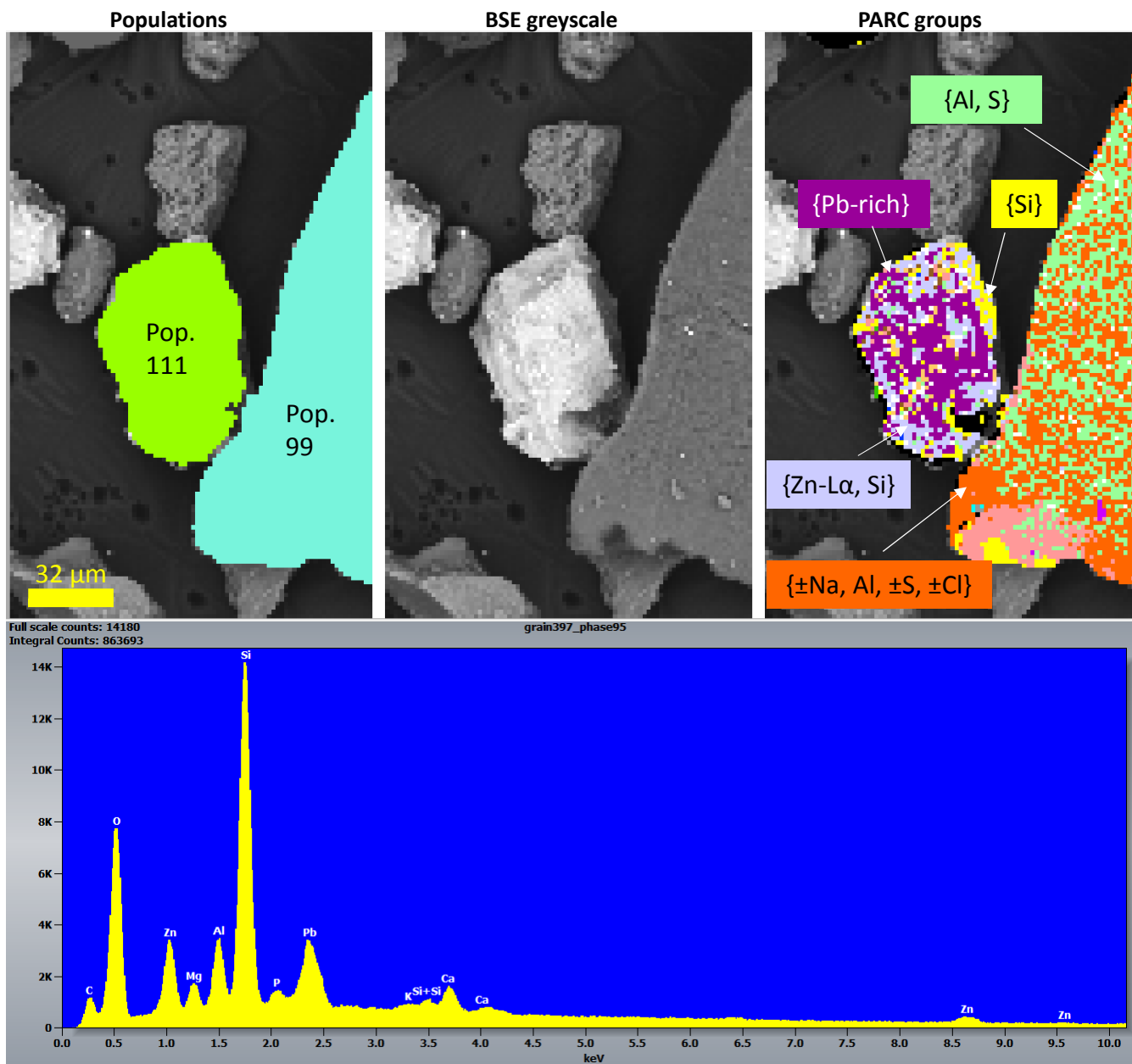
grain 1397			
Net Counts		Compound	%
C	3886	CO ₂	0.00
O	2532	(null)	0.00
Na	890	Na ₂ O	1.23
Mg	119	MgO	0.16
Al	784	Al ₂ O ₃	0.96
Si	3565	SiO ₂	4.60
P	772	P ₂ O ₅	0.99
S	6999	SO ₃	9.64
Cl	5124	Cl	4.88
K	295	K ₂ O	0.37
Ca	1228	CaO	1.89
Ti	0	TiO ₂	0.00
V	197	V ₂ O ₅	0.64
Cr	112	Cr ₂ O ₃	0.32
Mn	50	MnO	0.16
Fe	1259	FeO	4.38
Zn	197	ZnO	1.77
Ba	27	BaO	0.07
Pb	56677	PbO	67.94

S13B



Sum spectrum analysis (i)
 {Pb-rich} group in grain:
 289 pixels

grain 284			
Net Counts		Compound %	
C	5468	CO ₂	0
O	14632	(null)	0
Na	3873	Na ₂ O	2.62
Mg	4115	MgO	2.76
Al	8396	Al ₂ O ₃	5.37
Si	70237	SiO ₂	48.88
P	1568	P ₂ O ₅	1.27
S	2811	SO ₃	2.36
Cl	0	Cl	0
K	0	K ₂ O	0
Ca	5022	CaO	3.79
Ti	198	TiO ₂	0.26
V	0	V ₂ O ₅	0
Cr	148	Cr ₂ O ₃	0.23
Mn	0	MnO	0
Fe	798	FeO	1.57
Zn	2300	ZnO	12.5
Ba	206	BaO	0.29
Pb	24957	PbO	18.12

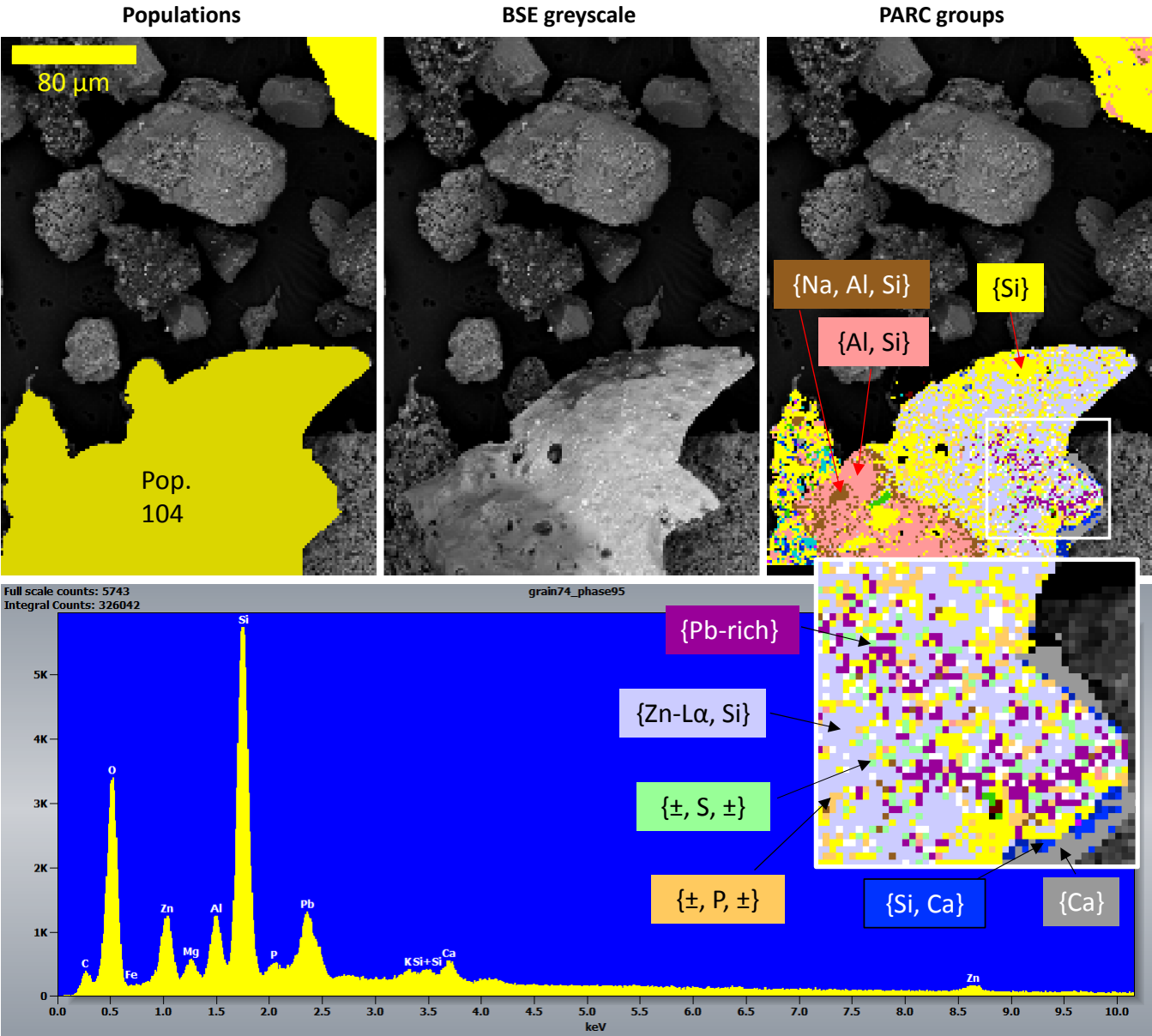


Sum spectrum analysis
{Pb-rich} group in grain:
570 pixels

(ii)

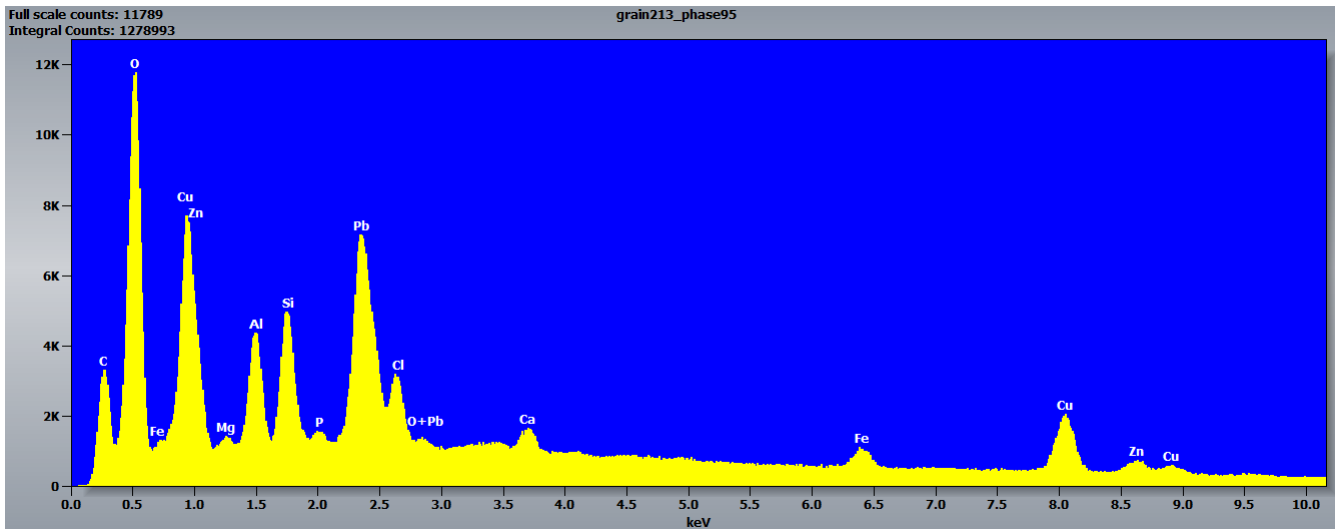
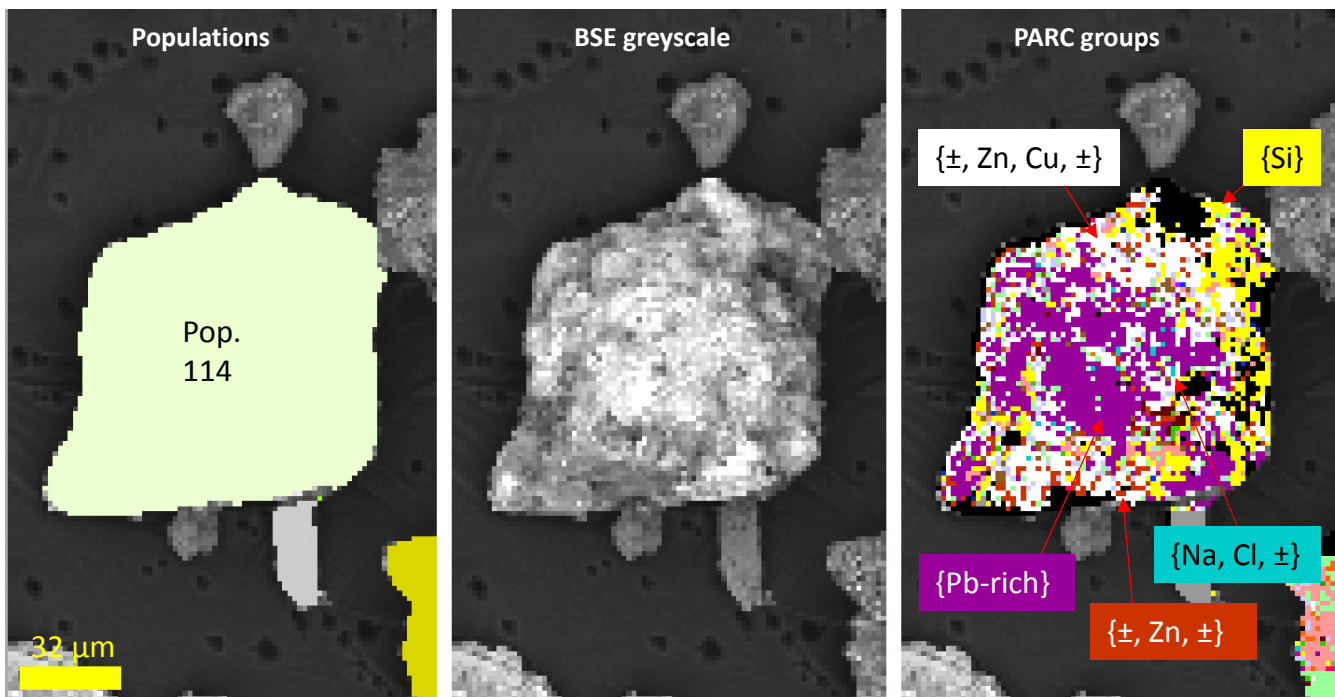
grain 397			
Net Counts		Compound %	
C	8414	CO ₂	0
O	24128	(null)	0
Na	8522	Na ₂ O	2.84
Mg	8646	MgO	2.87
Al	20819	Al ₂ O ₃	6.58
Si	130938	SiO ₂	45.12
P	4063	P ₂ O ₅	1.6
S	2745	SO ₃	1.12
Cl	0	Cl	0
K	0	K ₂ O	0
Ca	10715	CaO	3.96
Ti	437	TiO ₂	0.28
V	0	V ₂ O ₅	0
Cr	478	Cr ₂ O ₃	0.36
Mn	198	MnO	0.17
Fe	1360	FeO	1.3
Zn	5062	ZnO	13.34
Ba	422	BaO	0.29
Pb	57099	PbO	20.18

(iii)



Sum spectrum analysis
{Pb-rich} group in grain:
244 pixels

grain 74			
Net Counts		Compound %	
C	2606	CO2	0.00
O	10604	(null)	0.00
Na	3487	Na2O	2.96
Mg	2600	MgO	2.20
Al	7453	Al2O3	5.98
Si	54703	SiO2	47.83
P	1262	P2O5	1.27
S	2102	SO3	2.20
Cl	0	Cl	0.00
K	444	K2O	0.33
Ca	3343	CaO	3.15
Ti	25	TiO2	0.04
V	0	V2O5	0.00
Cr	303	Cr2O3	0.58
Mn	0	MnO	0.00
Fe	503	FeO	1.23
Zn	1965	ZnO	13.30
Ba	366	BaO	0.63
Pb	20191	PbO	18.29

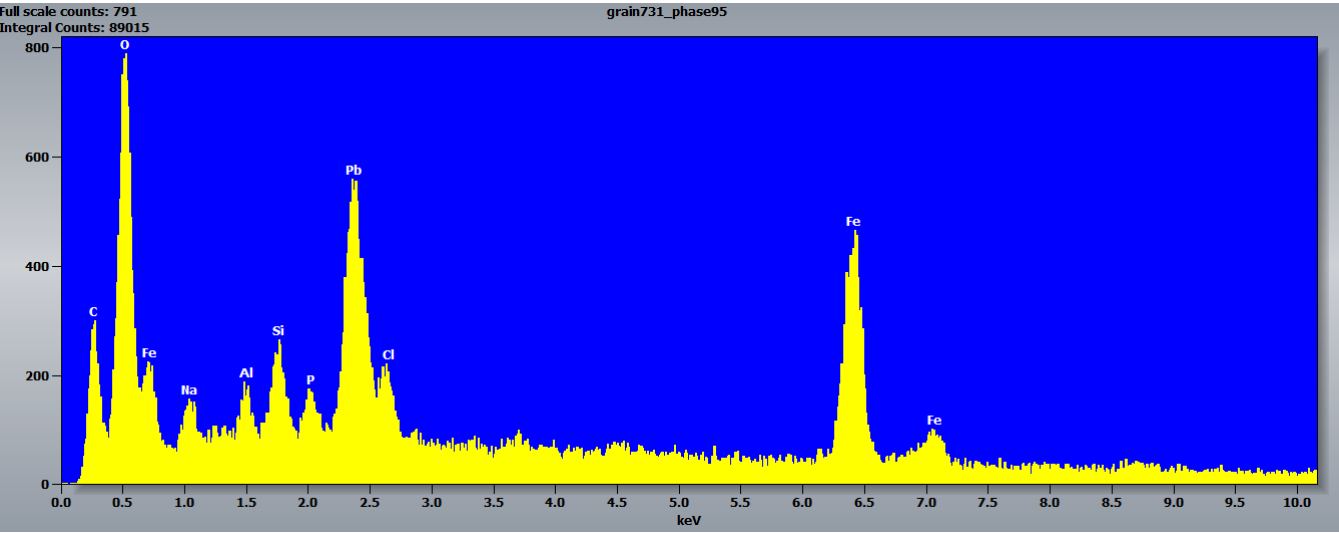
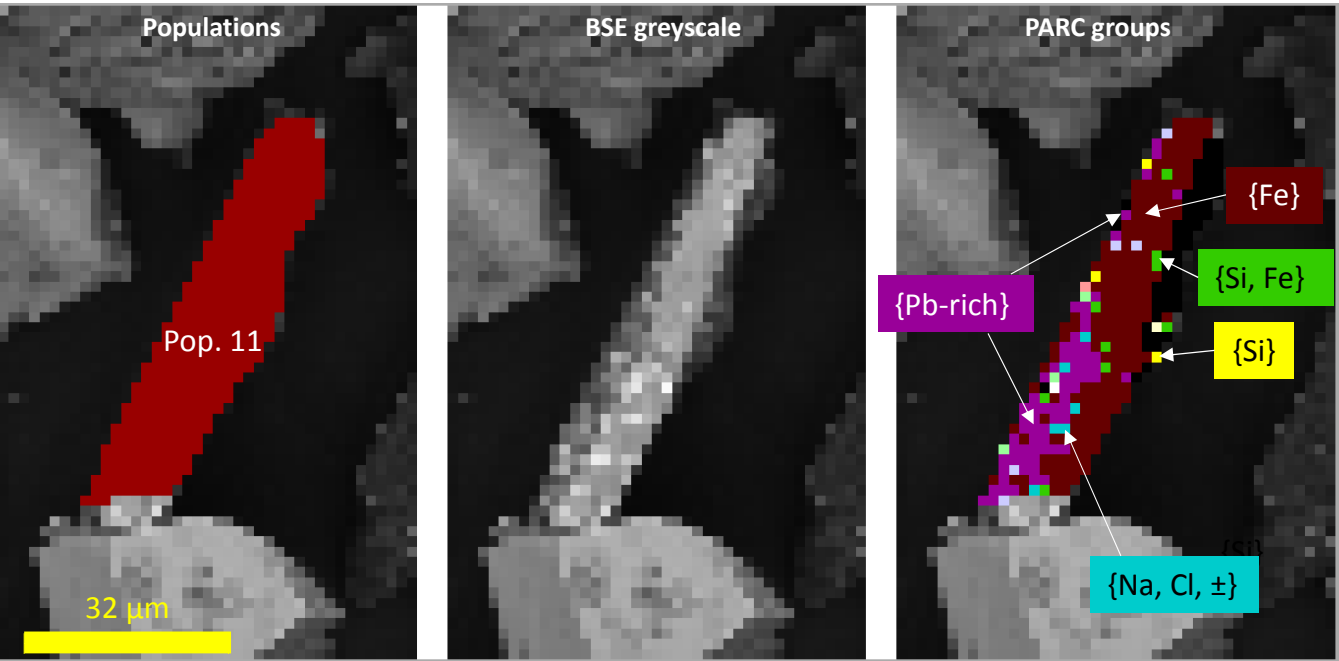


Sum spectrum analysis (iv)
{Pb-rich} group in grain:
991 pixels

grain 213			
Net Counts		Compound	%
C	21928	CO ₂	0.00
O	38046	(null)	—
Na	0	Na ₂ O	0.00
Mg	1824	MgO	0.46
Al	29606	Al ₂ O ₃	6.60
Si	35380	SiO ₂	8.11
P	4509	P ₂ O ₅	1.00
S	19675	SO ₃	4.52
Cl	25731	Cl	3.20
K	0	K ₂ O	0.00
Ca	8374	CaO	1.77
Ti	236	TiO ₂	0.09
V	893	V ₂ O ₅	0.42
Cr	7	Cr ₂ O ₃	0.00
Mn	286	MnO	0.14
Fe	9285	FeO	4.82
Cu	31489	CuO	34.46
Zn	6689	ZnO	9.80
Ba	1000	BaO	0.38
Pb	121767	PbO	24.24

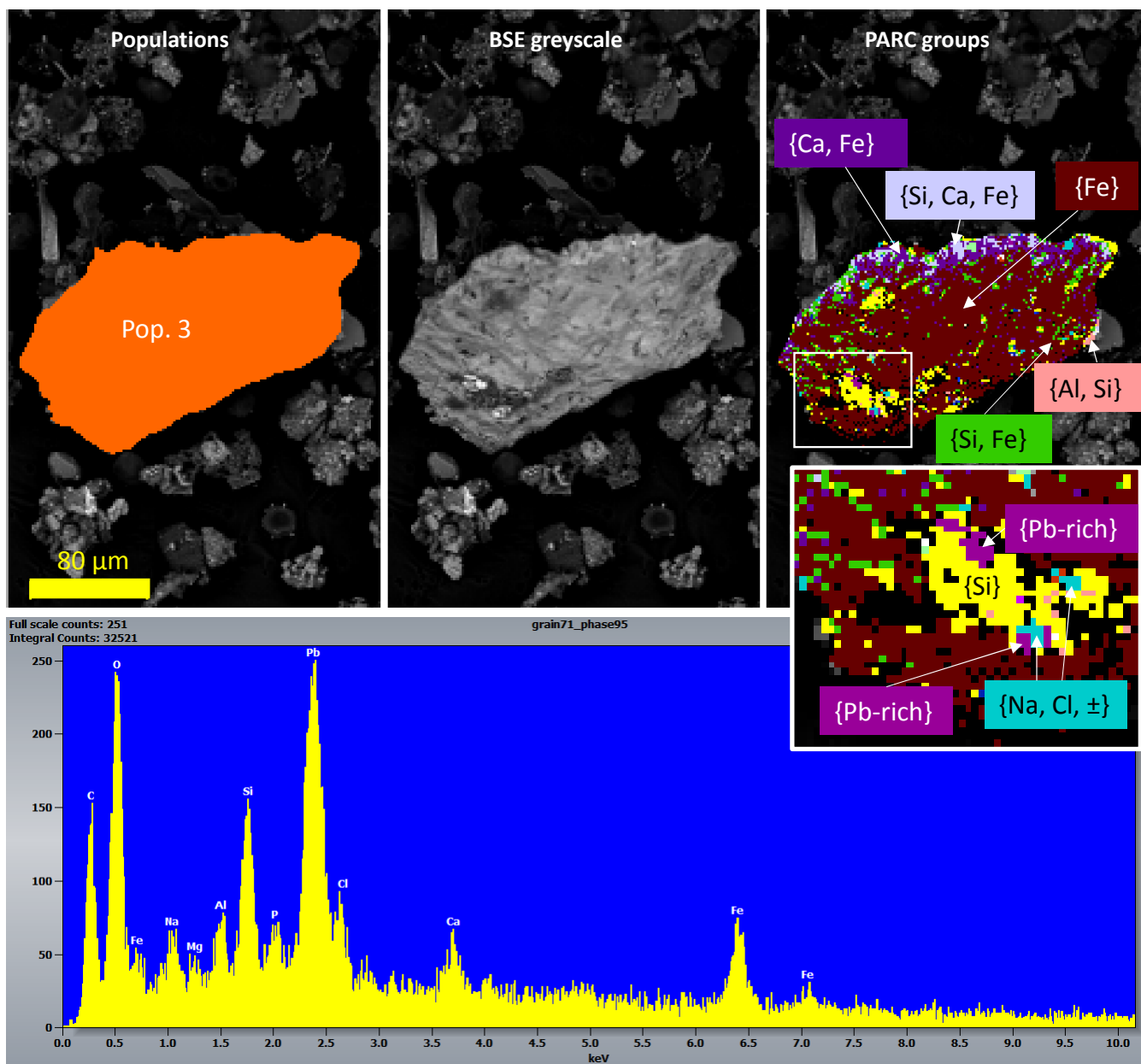
N.B. Cu not included as standard in other EDS analyses reported here

S13C



Sum spectrum analysis (i)
 {Pb-rich} group in grain: 69 pixels

		grain731	
Net Counts		Compound %	
C	2091	CO2	0.00
O	2463	(null)	0.00
Na	549	Na2O	1.97
Mg	0	MgO	0.00
Al	742	Al2O3	2.09
Si	1561	SiO2	4.51
P	922	P2O5	2.58
S	607	SO3	1.80
Cl	1732	Cl	2.83
K	177	K2O	0.39
Ca	277	CaO	0.78
Ti	187	TiO2	0.90
V	60	V2O5	0.37
Cr	31	Cr2O3	0.17
Mn	65	MnO	0.43
Fe	7227	FeO	52.33
Zn	95	ZnO	1.90
Ba	0	BaO	0.00
Pb	10483	PbO	26.95



Sum spectrum analysis (iii)
 {Pb-rich} group in grain: 34
 pixels

grain 71			
Net Counts		Compound %	
C	1023	CO ₂	0.00
O	775	(null)	0.00
Na	180	Na ₂ O	1.92
Mg	79	MgO	0.77
Al	314	Al ₂ O ₃	2.84
Si	1095	SiO ₂	10.39
P	373	P ₂ O ₅	3.55
S	86	SO ₃	0.88
Cl	544	Cl	3.32
K	45	K ₂ O	0.37
Ca	387	CaO	3.98
Ti	0	TiO ₂	0.00
V	105	V ₂ O ₅	2.37
Cr	17	Cr ₂ O ₃	0.34
Mn	70	MnO	1.59
Fe	929	FeO	23.37
Zn	10	ZnO	0.71
Ba	15	BaO	0.27
Pb	4902	PbO	43.35

S13D

Quantitative EDS analysis

Sum spectrum analysis – whole grain

Na2O wt%	MgO wt%	Al2O3 wt%	SiO2 wt%	P2O5 wt%	SO3 wt%	Cl wt%	K2O wt%	CaO wt%	TiO2 wt%	V2O5 wt%	Cr2O3 wt%	MnO wt%	FeO wt%	ZnO wt%	BaO wt%	PbO wt%
6.61	0	2.67	4.64	2.8	3.33	1.49	0.32	1.46	0.07	0.23	0.07	0.04	4.38	62.84	0	9.05

Constituent PARC groups

Na2O wt%	MgO wt%	Al2O3 wt%	SiO2 wt%	P2O5 wt%	SO3 wt%	Cl wt%	K2O wt%	CaO wt%	TiO2 wt%	V2O5 wt%	Cr2O3 wt%	MnO wt%	FeO wt%	ZnO wt%	BaO wt%	PbO wt%	PARC group	n pixels
7.67	0	2.46	3.42	2.6	2.04	1.44	0.23	0.54	0.07	0.21	0.05	0.04	3.54	70.25	0	5.46	{Zn-LA1}	1832
5.19	0	2.34	4.49	4.35	1.36	1.88	0.36	0.63	0.12	0.35	0	0.24	4.03	49.37	0.29	24.99	{Pb-rich}	426
5.88	0	5.47	13.75	2.73	2.61	1.41	0.64	0.74	0	0.56	0.09	0.17	6.71	54.21	0	5.03	{Na, Si}*	219
4.3	0	1.83	4.47	2.13	15.78	1.44	0.63	9.64	0.15	0.09	0.33	0	3.43	45.44	0	10.35	{ \pm , S, \pm }	210
1.5	0	0.54	4.28	0.64	49.52	0.55	0.55	33.98	0.14	0	0	0	0.77	5.82	0	1.71	{S, Ca}	22
4.27	0.28	1.16	3.6	1.62	1.97	0.51	0	1.17	0	0	0	0	49.72	31.2	2.38	2.13	{Zn-LA1, Fe}	22
4.32	0	1.68	4.53	3.09	0	1.27	0.47	1.09	0	0.8	0.28	0	6.53	55.84	1.06	19.04	{unclassified}	21
4.82	0	14.64	18.54	2.93	2.81	1.48	0.9	0.92	0	0	0.63	0.11	8.08	40.87	0	3.26	{ \pm Na, Al, Si, \pm K, \pm Ca}	18
1.13	7.69	10.27	43.02	0.88	5.38	0.55	1.16	8.05	0	0.93	0	5.15	2.15	12.64	0.99	0	{Si}	7
7.14	0	7.93	5.83	3.33	2.06	0.88	1.21	0	1.12	0	0	0	6.26	59.27	0.52	4.43	{Na, Al}	6
0	0.83	0.87	2.93	0.29	1.84	0.23	0	1.43	0.1	0	0	2.5	81.66	6.54	0	0.79	{Fe}	2
7.23	1.12	0.7	1.75	1.31	1.79	0	1.35	25.38	0.95	0	0	4.33	1.79	52.31	0	0	{Na, Ca}	1
0	0	3.02	14	0	0.91	0.82	0	0.23	0	0	3.95	1.01	45.22	23	4.77	3.06	{Zn-LA1, Si, Fe}	1

*{Na, Si} in this grain is in fact {Zn-LA1, Si}, i.e. the signal is dominated by Zn rather than Na. This phase is labelled {Zn, Si} in the PARC image.

