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Tin ores from Tregurra, Truro, Cornwall

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Dr T.P. Young

Abstract

Excavations at Tregurra found caches of tin ore (cassiterite) in four pits, all dating (according to ^{14}C determinations) to the early Bronze Age. The caches comprise stream tin (particles containing cassiterite from fluvial contexts), in natural particles ranging from coarse sand grade up to very large pebble grade (<35mm). One of the caches also included a large quantity of artificially crushed material, mostly of coarse to very coarse sand grade.

The origin of the ores was investigated through analysis of examples of the coarse pebbles. They proved to have complex, deformed, vein textures. Analyses of the tourmaline in the samples produced compositions equivalent to analyses of tourmaline from the tourmaline stage of mineralisation in veins with the metamorphic aureole.

Such mineralisation is to be found in close proximity to the exposed areas of granite. Since the particles were from placer deposits it is likely that they derived from a river at least moderately close to Tregurra. There are two potential general sources: the rivers (the Tresillian River particularly) flowing southwest from the area of the St Austell Granite to the east and southeast of the site, and the rivers flowing southeast from the northern side of the Carnmenellis Granite (the Carnon River and the stream flowing to Calenick Creek) to the west and southwest of the site. The latter area is closer to the site and probably the more likely source.

Contents

Methods

The assemblage from Tregurra was visually inspected as part of two phases of assessment (Young 2014b, 2015). The integrated catalogue from these assessments was included in Appendix A, Table A1, of Young 2016. The cassiterite collection is summarised by context and facies in Appendix A, Table A1).

Following the assessment, a strategy for investigation of the cassiterite-bearing materials was devised for investigation of the tin ores via assessment of the grade of the ore fines and examination of the texture of the large ore pebbles.

Selected pebbles from context (3416) were slabbed on a diamond saw and subsamples used firstly for preparing a polished block for use on the SEM. Polished blocks for investigation on the SEM were prepared in the Earth Science Department, The Open University. Electron microscopy was undertaken on the Zeiss Sigma HD Field Emission Gun Analytical Scanning Electron Microscope in the School of Earth and Ocean Sciences, Cardiff University. Microanalysis was undertaken using the system's energy-dispersive x-ray analysis system (EDS) controlled by Aztec software. The assistance of Dr Duncan Muir is gratefully acknowledged.

The site code used for the samples is TRU. Locations of EDS analyses are presented as sample-area-spectrum (e.g. TRU21 area2 spectrum3). The microanalytical data are presented in Appendix C. Images of all areas including analyses are included in Appendix D, including, where appropriate, details of the analysed points/areas.

All EDS analyses were collected with all elements analysed (including oxygen, but not carbon; all samples were carbon-coated). Area analytical totals were frequently far from 100%, because the analytical system is designed to provide totals of 100% from spot analyses in the centre of the field. The area analyses required for this project are not standardised in the same way and will diverge from a total of 100% (either above or below, depending on the location of the area with respect to the centre of the field). In order to make the microanalytical results simply comparable across materials (and also sites), no attempt has been made to adjust for the oxidation state of elements with variable valency. The figures employed in the report have therefore been constructed with elements expressed as oxides in weight% calculated stoichiometrically, except for mineral structure calculations, where the measured oxygen has been used.

Following acquisition and examination of the data derived from the pebbles, it was apparent that the fine grain size of the vein minerals would make it extremely difficult to derive meaningful data from examination of the bulk crushed fines. The problems of the investigation of the ore fines were compounded by the unknown loss of material during its initial sieving, by the presence of both primary stream tin grains and crushed ore in the same size fractions, and by the unknown proportion of the no-cassiterite material that was derived from deposited cache as opposed to from the other contributing sources to the pit fill. The project was therefore focused onto the pebbles and only a minimal investigation of the crushed ore was pursued.

This project was commissioned by Sean Taylor of Cornwall Council's Historic Environment Projects team.

Results

Distribution of the material

Cassiterite pebbles and/or crushed material were six contexts, representing the fills of four different pits ([2447], [2494], [3272], [3417]). All of these pits have provided radiocarbon dates, with pit [2447] having dates from both lower and upper fills:

- Context (2442), upper fill of pit [2447], 1866 - 1631 cal BC (SUERC-64580) structured deposit with Trevisker Ware.
- Context (2459), primary fill of pit [2447] 2025 - 1775 cal BC (SUERC-64448), fragile pottery identified on site as Grooved Ware.
- Context (2443) primary fill of pit [2494] 1901 - 1743 cal BC (SUERC-645840), with gabbroic admixture BA pot.
- Context (3218), upper fill of pit [3272], 2025 - 1886 cal BC (SUERC-64595), pot including possible Trevisker rim and Grooved Ware or Beaker sherds.
- Context (3416), primary fill of pit [3417], 1959 - 1768 cal BC (SUERC-64604)
- Context (3417), upper fill of pit [3417], not dated.

Description of the material

General

The unaltered tin ore was represented by rounded grains ranging from coarse sand grade up to grains of very large pebble grade (<35mm). The grains occasionally included rounded granules of iron ore, probably collected with the tin-bearing pebbles.

The pebbles are typically dense, but contain varying amounts of cassiterite, quartz and a fine-grained dark mineral aggregate, that analysis showed to be tourmaline. This mineralogy gives the pebbles external patterning, that may provide evidence for both ductile and brittle deformation structures.

Detailed examination was undertaken of two pebbles from context (3416) that showed contrasting external features. One (TRU19), showed good evidence for brittle deformation and brecciation of a cassiterite-dominated mineral assemblage, with the fine matrix rich in tourmaline.

A second pebble (TRU20) showed cross cutting mineralisation textures. Again, early cassiterite had been fractured with the emplacement of quartz, tourmaline and cassiterite, bearing narrow zones of highly foliated tourmaline-rich material carrying tiny grains of cassiterite, rutile, zircon and muscovite.

A third pebble (TRU21) was not examined in detail, but showed coarse, possibly pseudomorphic cassiterite in quartz.

The fines from fill (3416) were examined visually, and through beneficiating the ore by panning a 500g subsample. The concentrate was approximately 370g of a dark, fine-grained (mostly in the range 0.5mm to 2.5mm), dense fraction. The lighter fraction comprised mainly killas fragments, with a small proportion of quartz and feldspar sand. Although the nature of the evidence precludes certainty, the relatively low proportion of fine-grained quartz visible in the sample, suggests that the crushed ore had been processed (beneficiated), whether by panning or some other means, before deposition.

The density of the concentrate after panning was approximately 5.05g/ml. This would indicate a content of approximately 63-66% cassiterite assuming the remainder was a mixture of quartz and tourmaline.

The crushed ore has a finer grain-size than the equivalent material at Tolgarrick Farm (see below), and it was therefore not possible reliably to divide the ore into rounded and angular particles as undertaken with that assemblage.

Details of sampled materials

Pebbles, samples TRU19-21:

Sample TRU19 (Figures 1 upper; Archive Plates A1 – A5)

This sample comprises a deformed texture with indications of brittle deformation cutting a more ductile earlier deformation. The sample includes zones of quartz + tourmaline (the tourmaline is up to approximately 400µm in length and is zoned), sometimes with a trace of cassiterite and arsenopyrite and zones of quartz + cassiterite.

Sample TRU20 (Figures 1 middle; Archive Plates A6 – A8)
This sample comprises cassiterite in narrow (4mm) zones, with the main cassiterite zone acutely intersected by a foliation, along which are narrow zones of cassiterite, quartz, tourmaline and a very fine-grained foliated tourmaline-rich material, bearing tiny (<50µm) grains of cassiterite, rutile, zircon and muscovite.

Sample TRU21 (Figures 1 lower; Archive Plates A9)
This sample comprises a very cassiterite-rich material. The cassiterite shows a coarse structure, possibly, but not certainly pseudomorphic. The cassiterite is set in quartz.

Details of mineralogy

The samples were dominated by three main minerals: cassiterite, quartz and tourmaline, with minor quantities of arsenopyrite, muscovite, zircon and rutile(?) also recorded (Table A3). The quality of the microanalysis was only moderate. The variability of the material meant that calibration with equivalent matrix was not possible and the very fine-grained nature of much of the material meant that even very small volumes were commonly mixtures. Comparison of the present data with published material, often derived from high-quality microprobe analyses on coarser-grained samples, must be made with some caution.

Cassiterite: the EDS microanalyses of cassiterite were of rather poor quality, with analytical totals commonly in the range of 106% to 107.5%, probably due to poor calibration for tin (with minor errors on estimates of atomic% being amplified when converting to wt% because of the high atomic weight of tin compared to the other components). The data suggest that iron is probably present at levels of less than 0.7% (expressed as Fe_2O_3). All the cassiterite analyses showed peaks for aluminium, silicon and potassium, perhaps indicating admixture of some sericitic material.

Quartz: quartz was present widely in the samples, mostly as a fine-grained material.

Tourmaline: the tourmaline is typically very fine grained. In one area of TRU19 grain sizes as large as 400 µm in length were recorded, but this was exceptional (and was the only area in which zoning was visible in the tourmaline).

When plotted on the ternary diagram employed by Farmer *et al.* (1991; after Deer *et al.* 1986), the tourmaline from TRU20 is seen to be slightly more aluminous than that of TRU19 (Figure 2). The analyses from TRU20 plot close to the schorl-dravite join and the analyses of tourmaline of the tourmaline stage at South Crofty, whereas those from TRU19 plot more towards the tourmaline of the chlorite stage.

When plotted on a plot of Ti v Fe content (Farmer *et al.* 1991), the wide scatter of the datapoints demonstrates a wide range of Ti:Fe ratio, although poor data quality might also be an influence (Figure 3). Again, although some of the new data lie outside the fields observed by Farmer, the data from TRU20 plot close to his field of data from the tourmaline zone whereas that from TRU19 plots slightly more towards the tourmaline of the chlorite stage.

The discrimination diagram employed by Manning (1991) shows the greatest concordance with the present data when using his data for tourmaline from the metamorphic aureole at Botallack, which occupy the high R^{3+}/low (R^{+} + R^{2+}) section of the field of data from the metamorphic aureole (Figure 4). Similarly, the work of London & Manning (1995) emphasises that magmatic tourmaline has high Fe/Mg, high fluorine and high aluminium in the place of divalent ions in the R2 sites, where the hydrothermal tourmaline is more magnesian and closer to the scorl-davite solid solution. Figure 1 shows that the present data mostly show a higher Fe:Mg ratio than the magmatic tourmaline.

Overall, the tourmaline more closely resembles examples from within the metamorphic aureole of the granite than they do examples from within the granite, or from within greisens. There is overlap with both Manning's (1991) data from the metamorphic aureole and from quartz-tourmaline rocks, but the new data have a smaller range of variation.

Rutile: small grains of a titanium oxide (probably rutile) occurred in the very fine-grained foliated zones with sample TRU20. The analyses show poor totals, and have low levels of vanadium, iron and tin.

Zircon: small grains of zircon occurred in the very fine-grained foliated zones with sample TRU20. The analyses show an average of 0.0087 hafnium:zirconium.

Muscovite: small grains interpreted as muscovite occurred in the very fine-grained foliated zones with sample TRU20. The grains showed low levels of iron and magnesium, in addition to a small proportion of sodium substituting for potassium.

Arsenopyrite: a small quantity of partially-oxidised arsenopyrite was observed intercalated within the cassiterite of some areas of sample TRU19.

Interpretation

In general, tourmaline has been traditionally considered as forming the gangue to cassiterite in the deeper parts of the tin zone (Dines 1956, 6). In combination with the observation that the tourmaline is most likely from the metamorphic aureole of the granite, then (on the assumption that the source of the cassiterite bearing sediment was not a distant part of the orefield) likely source areas for the originating mineral veins can be proposed: firstly, the area to the north of the Carnmenellis Granite and secondly, areas around the St Austell Granite.

The actual source of the granules forming the cache would not have been the site of mineralisation but placer deposits at some distance (to allow for the high degree of rounding of these hard lithologies). Both these source areas are known to be associated with large downstream tin streaming. The drainage from the St Austell aureole incudes the valley of the River Fal the Tresillian River; the drainage from the area north of the Carnmenellis Granite by the valley of Carnon River and the stream draining into Calenick Creek (Figure 5).

The Trevella Stream runs southwards just to the east of Tregurra, but drains from the eastern part of the St Agnes sector of the orefield, which is known for its lead and zinc, so is unlikely to have produced cassiterite-tourmaline rich sediment. The source of the stream tin pebbles was therefore probably not particularly close to Tregurra.

The sites of Tregurra, Tolgarrick Farm and Threemilestone lie closer to the river systems carrying sediment southeastwards from the northern side of the Carnmenellis Granite, then they do to the rivers varying sediment from the area of the St Austell Granite.

Discusssion

The river valleys to the SW of Truro (of which the Carnon is the largest and best-studied) are known to have contained large amounts of alluvial placer deposits. The presence of similar occurrences of Bronze Age caches of cassiterite at Tolgarrick Farm (Young 2016a) and Threemilestone (Young 2008) would also favour a southwestern derivation for the cassiterite at Tregurra.

Early Bronze Age activity in the Carnon area has also been suggested by the tentative provenancing of the gold in the Nebra Sky Disk to a source sharing geochemical characteristics with the gold in the Carnon (Ehser *et al.* 2011), which is more abundant than in the rivers draining the area of the St Austell Granite.

The cassiterite at Tolgarrick Farm (Young 2016a) occurred in two significant contexts (each the fill of a small pit), (2092) and (2511), together with one isolated pebble from (2297). Neither of the pits containing cassiterite was scientifically dated. The pit containing fill (2511) was within sunken-floored structure F2057. There was a total of approximately 2.4kg of cassiterite, including rounded natural particles from 250µm up to and crushed material, mostly in the 2 to 5.6mm range (1.1kg – 47% of the assemblage). Context (2092) produced just 545g of cassiterite, of which just 14% appeared to have been crushed. In both cases the broken material included a proportion of fractured pebbles that had not been reduced to fines.

At Threemilestone, a single pit, identified as a posthole, produced four broken pebbles of tin ore. One was examined in detail (as sample RLS13) and it showed anhedral quartz of up to 1.5mm, set in mass of finer-grained cassiterite, and thus resembling sample TRU21 (Young 2008, Plate 7).

The three occurrences are therefore similar and may represent similar acts of deposition. On none of the three sites is there convincing evidence for early Bronze age metallurgical activity. None of the three sites is directly adjacent to a potential source of stream tin. It is interesting, although quite possibly entirely coincidental, that all three sites appear to have also similarly undertaken iron smelting in the Middle Iron Age, using an iron ore, possibly from the same general area as that from which the stream tin had been derived in the early Bronze Age.

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Figure Captions

Figure 1: Backscattered electron image collages of cassiterite-bearing pebbles from Tregurra. Cassiterite is bright; the dull matrix comprises mainly quartz and tourmaline, with the tourmaline slightly paler than quartz.

Figure 2: Fe-Mg-Al ternary diagram of EDS analyses of tourmalines in pebbles TRU19 (crosses) and TRU20 (circles) from Tregurra. Fields after Farmer *et al.* (1991) for observations at South Crofty (North of Carnmenellis Granite) for tourmaline from the granite (grey tone), tourmaline zone (solid outline) and chlorite zone (dotted line).

Figure 3: Plot of titanium vs iron per unit cell, for EDS analyses of tourmalines in pebbles TRU19 (crosses) and TRU20 (circles) from Tregurra. Fields after Farmer *et al.* (1991) for observations at South Crofty (North of Carnmenellis Granite) for tourmaline from the granite (grey tone), tourmaline zone (solid outline) and chlorite zone (dotted line).

Figure 4: Plot of (R^{+} + R^{2+}) against R^{3+} for EDS analyses of tourmalines in pebbles TRU19 (crosses) and TRU20 (circles) from Tregurra. Fields after Manning's (1991) compilation of tourmaline analyses from SW England.

Figure 5: Location of the sites referred to in the text (1: Tregurra, 2: Tolgarrick Farm, 3: Threemilestone) with respect to the geology (simplified after Dines 1956) and drainage.

Pink tones: outcropping granites
Green: approximate margin of metamorphic aureole
Grey tone: principle areas of tin mineralisation

Named rivers:
C – Carnon River
Ck – stream feeding Calenick Creek
Ta – Travella Stream
Tn – Tresillian River
F – Fal

Table 1: Summary catalogue by context and sample

context	sample	feature	other	sample wt (g)	item wt (g)	item no	notes
Field 2							
2442	223	pit [2447] upper fill	cassiterite	498	498	99	5-35mm pieces, all rounded, some fragments my not be cassiterite
2442	274	pit [2447] upper fill	cassiterite	76	76	80	up to c12mm
2443/2476	285	pit [2494] primary fill		4	4	1	small dense rounded pebble - probably cassiterite
2459	275	pit [2447] lower fill	cassiterite	20	20	c40	small rounded, polished granules
2459		pit [2447] lower fill	cassiterite	24	24	11	granules
Field 3							
3218		pit [3272] upper fill		6	6	1	probable cassiterite-bearing pebble
3414	345	pit [3417] upper fill	cassiterite	192	192	12	12-32mm gravel
3414	345	pit [3417] upper fill	cassiterite	132	132	27	24 probable good ore, 3 probably not ore
3414		pit [3417] upper fill	cassiterite	2270	2270	38	mostly >20mm pebbles with cassiterite in varying amounts - mostly not good high grade material
3416	346	pit [3417] primary fill	cassiterite	9095			fines sieved from residue of pit with cassiterite - extremely dense
3416	346	pit [3417] primary fill	cassiterite	24	24	3	up to 20mm
3416		pit [3417] primary fill	cassiterite	1250	332	8	cobbles with perhaps a little cassiterite, but probably none in some cases
					696	13	cobbles with density suggesting cassiterite present
					216	1	broken cobble fragment with good mineralisation of cassiterite

Figure 1

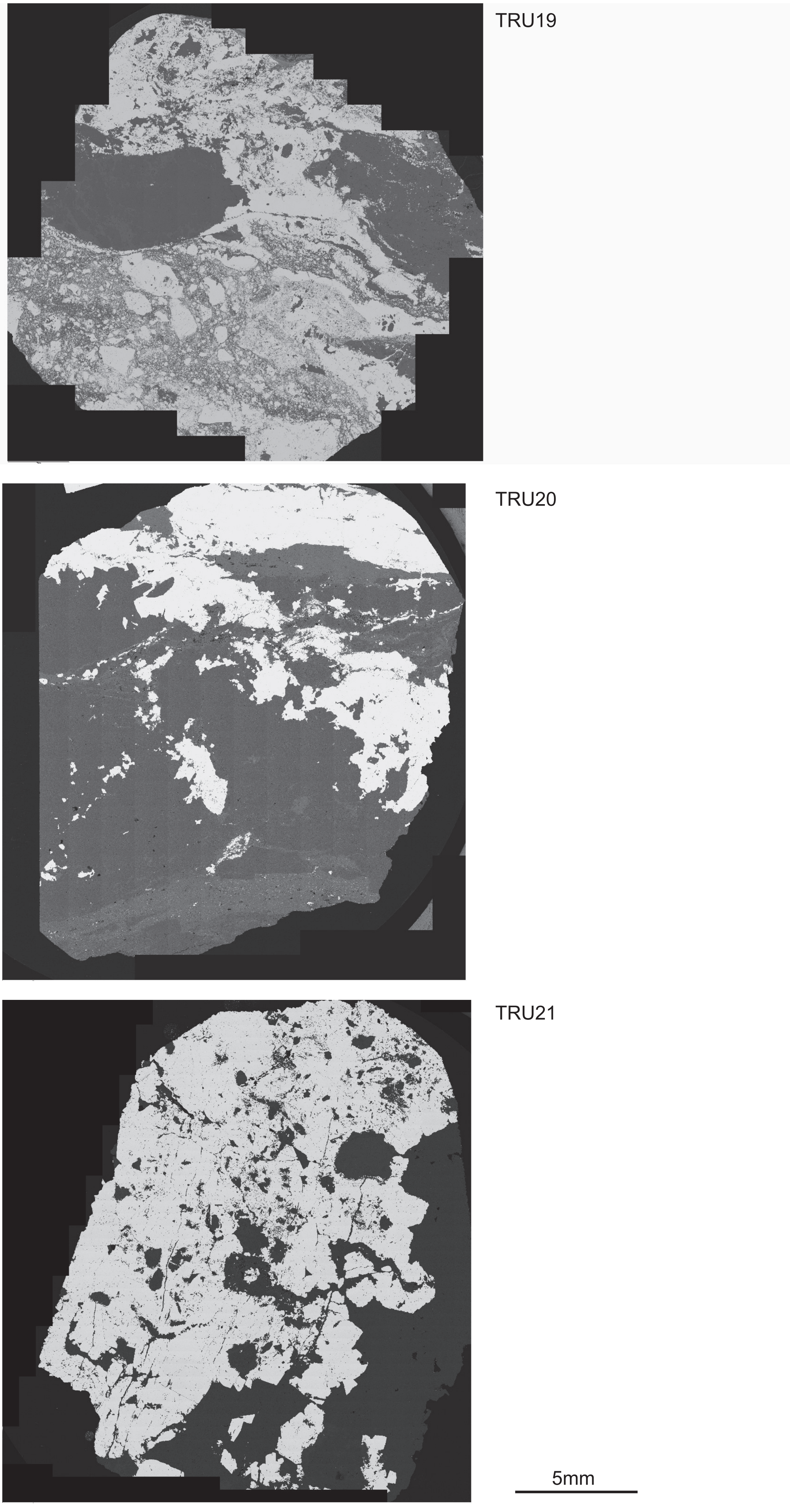


Figure 2

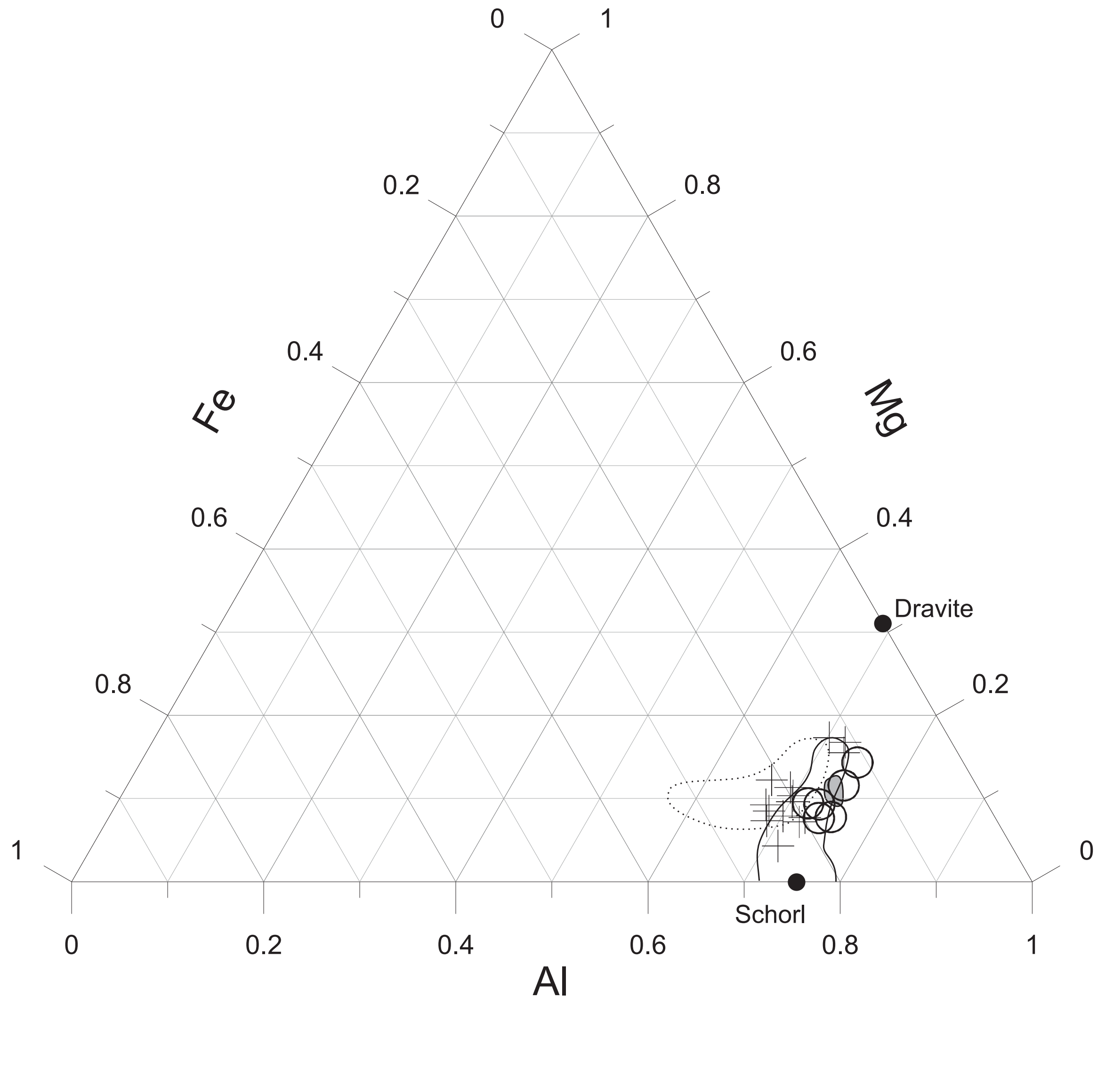
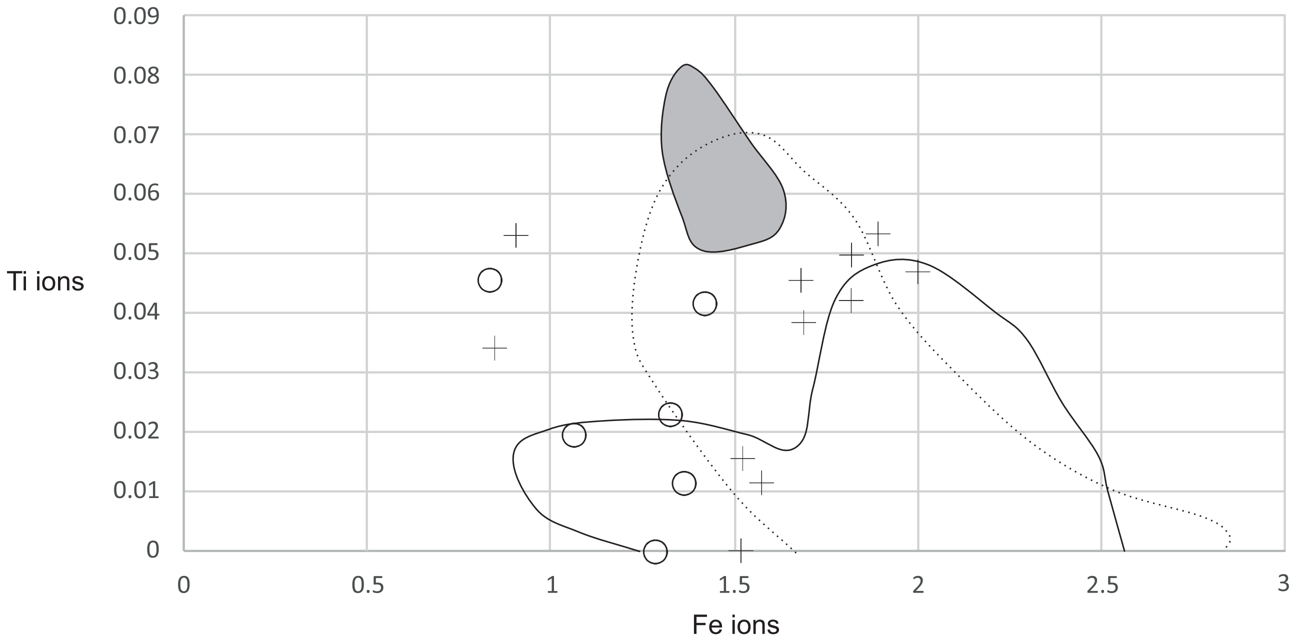
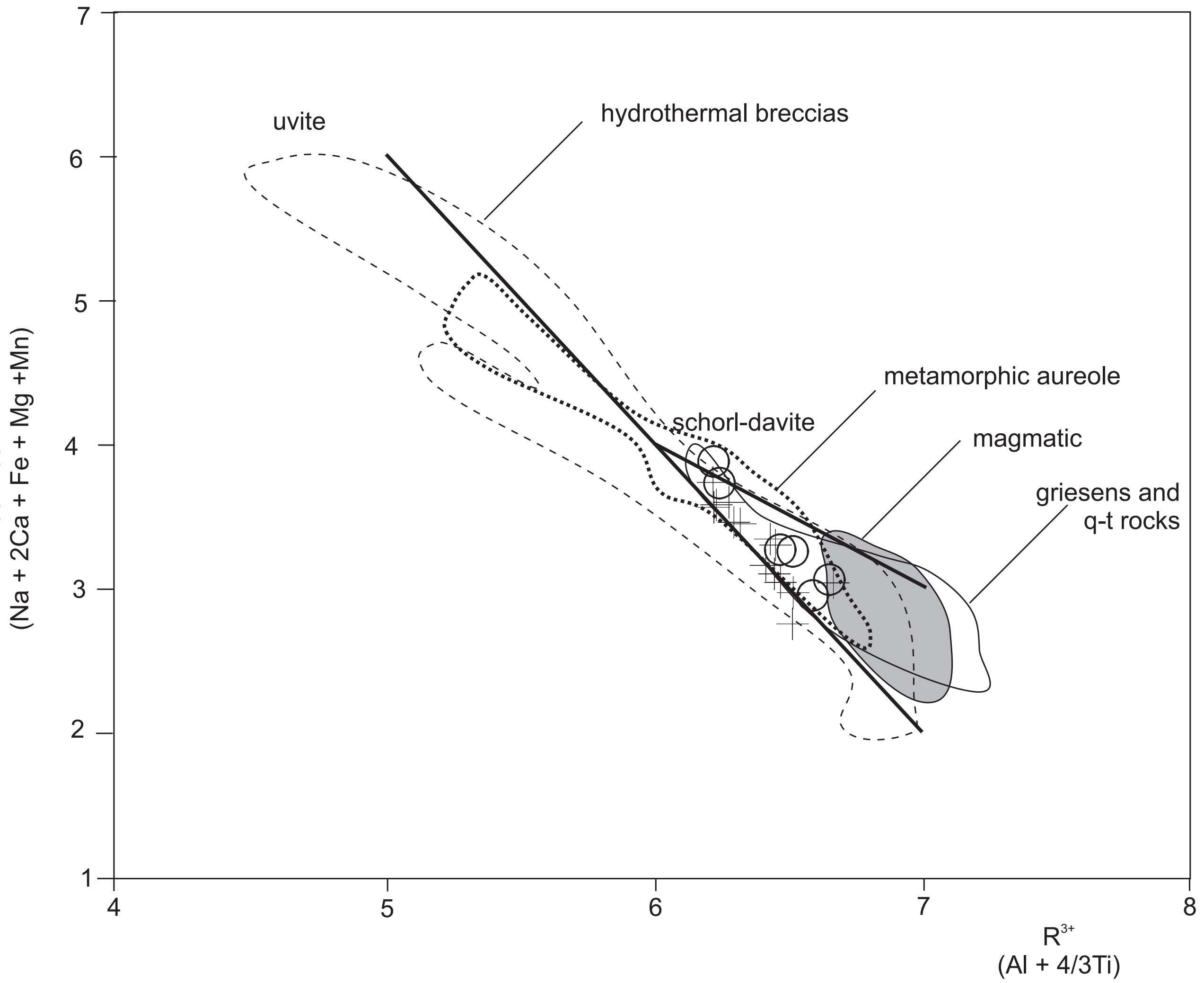


Figure 3



0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Ti ions
0
0.5
1
1.5
2
2.5
3
Fe ions

Figure 4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hydrothermal breccias
metamorphic aureole
schorl-davite
magmatic
griesens and
q-t rocks
7
6
5
4
3
2
1
4
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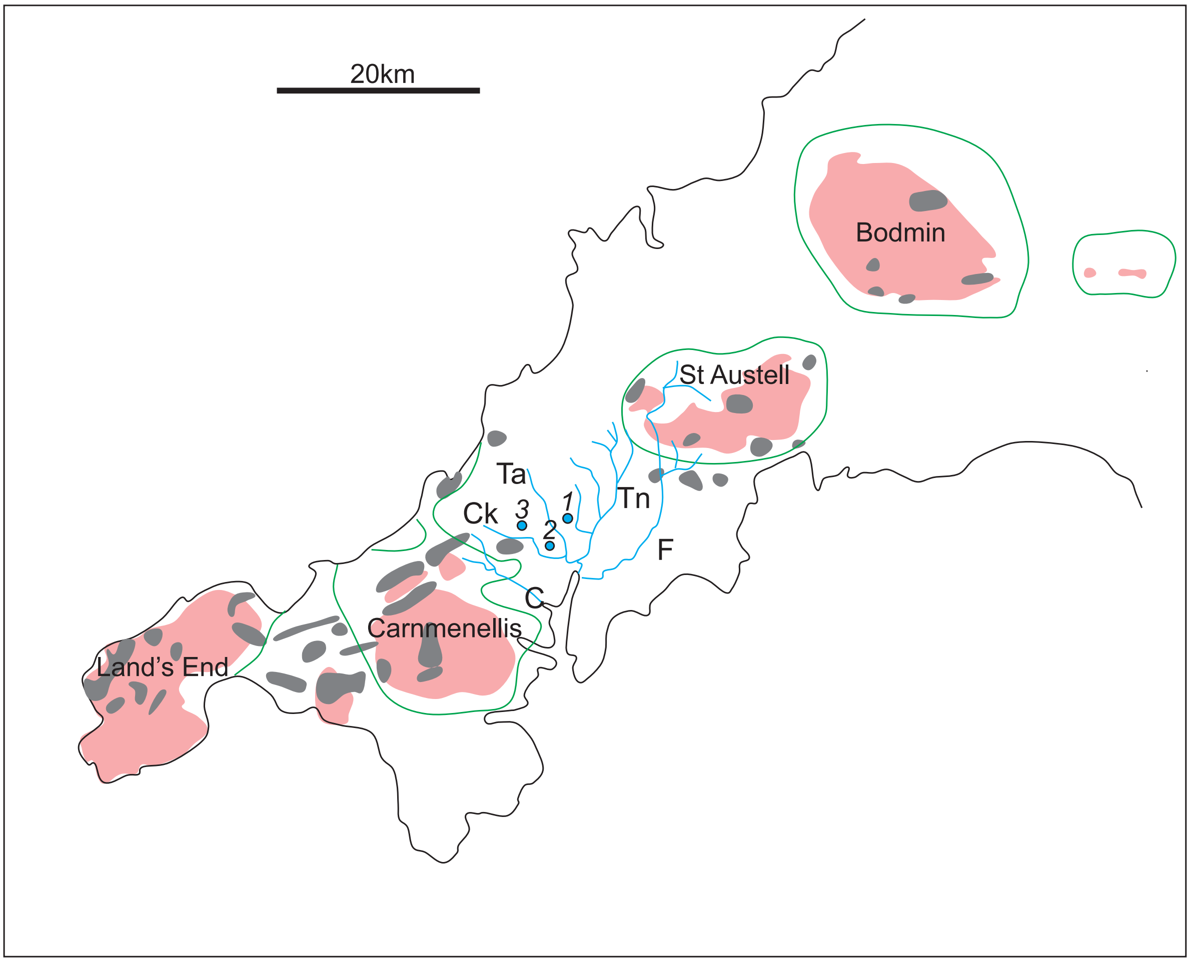
7
8
$R^{+} + R^{2+}$
(Na + 2Ca + Fe + Mg +Mn)
R^{3+}
(Al + 4/3Ti)

Figure 5



20km
Bodmin
St Austell
Ta
Ck
3
1
2
Tn
F
C
Carnmenellis
Land's End

Appendix A
EDS microanalyses

Table A1: EDS analyses for sample TRU19. All elements were measured. Presented as normalised atomic% with the analytical total in wt% in the right-hand column.

Spectrum Label	B	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Sn	Ba	wt% Total
Spectrum 389		71.07	1.18	1.58	9.78	8.43	0	0	0	0.1	0.14	0	0	0	0	2.37			5.35	0	115.41
Spectrum 390	0	64.28	1.43	1.8	14.54	13.56	0	0	0	0	0.08	0.08	0	0	0.04	4.19			0	0	92.66
Spectrum 391		64.49	1.56	1.59	14.12	13.56	0	0	0	0	0.13	0.12	0	0	0	4.43				0	92.69
Spectrum 392		17.07	0.5	0	0	0.17	0	26.94	0	0	0	0	0	0	0	26.13	0	28.93	0.26	0	104.41
Spectrum 393		65.18	0	0	0	34.82	0	0	0	0	0	0	0	0	0	0				0	97.81
Spectrum 394		65.1	0	0	0	34.84	0	0	0	0	0	0	0	0	0	0.05				0	98.52
Spectrum 395		64.15	1.48	1.91	13.97	13.42	0	0	0	0	0.16	0.13	0	0	0	4.77				0	90.96
Spectrum 396		64.3	1.32	0.88	14.56	13.79	0	0	0	0	0.05	0.14	0	0	0	4.96				0	92.32
Spectrum 397		64.25	1.66	2.09	14.14	13.62	0	0	0	0	0.21	0.04	0	0	0	3.99				0	93.08
Spectrum 398		65.4	0	0	0	34.57	0	0	0	0	0	0	0	0	0	0.04				0	97.69
Spectrum 399		62.78	1.56	1.57	14.7	13.99	0	0	0	0.03	0.13	0.12	0	0	0	5.13				0	86.49
Spectrum 400		64.12	1.64	1.75	14.05	13.38	0	0	0	0	0.16	0.11	0	0	0.03	4.76				0	91.15
Spectrum 401		64.46	1.74	1.56	14.64	13.5	0	0	0	0	0.05	0	0	0	0.05	4				0	93.87
Spectrum 402		64.83	1.51	1.45	14.52	13.37	0	0	0	0	0.11	0.03	0	0	0	4.16				0	96.07
Spectrum 403		69.96	0	0.17	1.23	16.24	0	0	0	0.14	0	0	0	0	0	0.35			11.9	0	122.27
Spectrum 404		65.28	0	0	0.05	34.63	0	0	0	0	0	0	0	0	0	0.04				0	97.98
Spectrum 405		68.58	0	0	0.25	0.14	0	0	0	0.36	0.29	0	0	0	0	0.35			30.02	0	105.3
Spectrum 406		68.48	0	0	0.32	0	0	0	0	0.36	0	0	0	0	0	0.61			30.22	0	107.02
Spectrum 407		68.03	0	0	0.3	0	0	0	0	0.28	0.29	0	0	0	0	1.01			30.09	0	106.98
Spectrum 408		64.2	1.54	2.3	14.27	13.44	0	0	0	0	0.16	0.13	0	0	0	3.91			0.05	0	92.83
Spectrum 409		64.39	1.58	1.94	14.16	13.56	0	0	0	0	0.14	0.16	0	0	0	4.07				0	94.01
Spectrum 410		63.9	1.49	2.57	14.02	13.26	0.06	0	0	0	0.18	0.1	0	0	0	4.41			0	0	92.23
Spectrum 411		64.59	1.61	3.43	13.91	13.43	0	0	0.03	0	0.03	0.51	0	0	0	2.47				0	94.02
Spectrum 412		64.59	1.43	3.39	14.58	13.61	0	0	0	0	0	0.09	0.03	0.03	0	2.24				0	94.08
Spectrum 413		64.71	1.16	3.14	14.7	13.68	0	0	0	0	0.03	0.14	0	0.03	0	2.4				0	93.28
Spectrum 414		64.5	1.5	2.38	14.1	13.41	0.05	0	0	0	0.18	0.13	0	0	0	3.76				0	93.28
Spectrum 415		71.64	0.64	0.95	5.59	6.94	0	0	0	0.23	0	0	0	0	0	1.2			12.8	0	120.03
Spectrum 416		68.67	0	0	0.38	0.13	0	0	0	0.42	0	0	0	0	0	0.29			30.12	0	105.96
Spectrum 417		64.36	1.46	2.23	13.02	15.26	0	0	0	0	0.17	0.11	0	0	0	3.39				0	92.9
Spectrum 418		65.97	0.3	0.48	3.29	29.06	0	0	0	0	0.04	0	0	0	0	0.87				0	81.96
Spectrum 419		65.1	0	0	0.11	34.65	0	0	0	0	0	0	0	0	0	0.14				0	99.61
Spectrum 420		58.11	1.57	2.68	15.86	16.32	0	0	0.19	0	0.25	0.21	0	0	0	4.75			0.06	0	62.8
Spectrum 421		64.6	1.56	2.26	13.79	13.54	0	0	0	0	0.17	0.19	0	0	0	3.89				0	95.13

Spectrum Label	B	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Sn	Ba	wt% Total
Spectrum 422		65.1	0	0	0	34.83	0	0	0	0	0	0	0	0	0	0.07				0	99.13
Spectrum 423		72.13	0.47	0.52	3.92	8.68	0	0	0	0.15	0.14	0	0	0	0	1.02			12.98	0	121.79
Spectrum 424		65.87	0	0	0	33.93	0	0.04	0	0	0.09	0	0	0	0	0.06				0	98.99
Spectrum 425		64.3	1.04	0.74	11.22	19.33	0	0	0	0	0.14	0	0	0	0	3.24				0	102.58

Table A2: EDS analyses for sample TRU20. All elements were measured. Presented as normalised atomic% with the analytical total in wt% in the right hand-column.

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Ba	Hf	W	wt% Total
Spectrum 426	67.56	0	0	0.27	0.16	0	0	0	0.38	0	0	0	0	0	0.12				31.51	0			104.64
Spectrum 427	68.64	0	0	0.23	0.15	0	0	0	0.44	0.26	0	0	0	0	0.18				30.1	0			106.68
Spectrum 428	69.15	0.15	0.18	1.15	22.22	0	0	0	0.11	0	0	0	0	0	0.43				6.61	0			123.46
Spectrum 429	64.78	1.37	1.86	14.63	13.69	0	0	0	0	0.1	0.06	0	0	0	3.5					0			94.2
Spectrum 430	64.88	1.49	1.9	14.49	13.27	0	0	0	0	0.1	0.11	0	0	0	3.75					0			95.36
Spectrum 431	65.39	0	0	0	34.58	0	0	0	0	0	0	0	0	0	0.03					0			99.97
Spectrum 432	65.44	0	0	0	34.53	0	0	0	0	0	0	0	0	0	0.03					0			99.96
Spectrum 433	64.56	1.51	2.35	15.14	13.47	0	0	0	0	0.11	0.05	0	0	0	2.81					0			94.44
Spectrum 434	65.41	1.23	1.52	14.68	13.32	0	0	0	0.03	0.08	0.03	0	0	0	3.65				0.05	0			95.84
Spectrum 435	64.75	1.24	1.55	14.96	14.02	0	0	0	0	0.04	0	0	0	0.04	3.4				0	0			96.57
Spectrum 436	64.87	1.36	1.79	14.88	13.31	0	0	0	0	0.08	0.07	0	0	0	3.63					0			94.87
Spectrum 437	65.57	0	0	0.12	34.25	0	0	0	0	0	0	0	0	0	0.06					0			100.37
Spectrum 438	68.49	0	0	0.3	0	0	0	0	0.46	0	0	0	0	0	0.27				30.48	0			107.99
Spectrum 439	64.42	0.35	0.6	7.96	23.74	0	0	0	1.67	0.05	0.45	0	0	0	0.76					0			100.97
Spectrum 440	68.67	0	0	0.1	0.25	0	0	0	0.05	0	29.89	0.25	0	0	0.27				0.43	0		0.08	108.91
Spectrum 441	60.73	0	0	0.4	0.19	0	0	0	0.44	0.53	0.3	0	0	0	0.37				37.03	0			94.45
Spectrum 442	66.73	0	0	0.36	15.56	0.68	0	0	0	0.26	0	0	0	0	0.22			16.07		0	0.1		94.01
Spectrum 443	65.79	0	0.17	5.06	6.32	0	0	0	2.09	0.12	19.94	0.19	0	0	0.33					0			90.42
Spectrum 444	64.76	0	0	0.09	17.46	0	0	0	0.06	0	0	0	0	0	0.1			17.39		0	0.1		97.65
Spectrum 445	68.34	0	0	0.1	0.32	0	0	0	0	0	30.42	0.28	0	0	0.2				0.35	0			105.72
Spectrum 446	65.07	0	0	0.18	0.44	0	0	0	0	0.16	33.67	0.25	0	0	0.23					0			97.33
Spectrum 447	67.42	0	0	0.31	0.26	0	0	0	0.4	0	0.31	0	0	0	0.33				30.98	0			106.38
Spectrum 448	67.72	0	0	0.29	0.14	0	0	0	0.5	0	0.6	0	0	0	0.31				30.43	0			106.59
Spectrum 449	65.64	0	0	0.13	34.19	0	0	0	0	0	0	0	0	0	0.04					0			96.89
Spectrum 450	68.33	0	0	0.32	0.37	0	0	0	0.4	0	0.43	0	0	0	0.52				29.64	0			107.42
Spectrum 451	65.03	0	0	0.09	17.43	0	0	0	0	0	0.07	0	0	0	0.13			17.12		0	0.1		97.65
Spectrum 452	64.6	0	0	0.13	17.62	0	0	0	0.06	0	0	0	0	0	0.14			17.25		0	0.2		96.02
Spectrum 453	68.59	0	0	0.4	0.2	0	0	0	0.37	0	0	0	0	0	0.2				30.13	0.11			107.5
Spectrum 454	67.82	0	0	0.18	0.17	0	0	0	0	0	30.99	0.21	0	0	0.17				0.46	0			103.63
Spectrum 455	68.07	0	0	0.12	0.09	0	0	0	0	0	31.11	0.22	0	0	0.17				0.22	0			105.41
Spectrum 456	68.17	0	0	0.13	0.44	0	0	0.05	0	0	29.98	0.19	0	0	0.34				0.7	0			103.37
Spectrum 457	63.94	0.27	0.49	8.05	24.27	0	0	0	2.05	0.03	0.26	0	0	0	0.63					0			100.34
Spectrum 458	65.41	0	0.05	0.41	34.06	0	0	0	0	0	0	0	0	0	0.07					0			99.76
Spectrum 459	67.82	0	0	0.31	0.2	0	0	0	0.44	0	0.32	0	0	0	0.3				30.61	0			106.19

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Ba	Hf	W	wt% Total
Spectrum 460	67.51	0	0	0.13	0.28	0	0	0	0	0	31.12	0.22	0	0	0.27				0.47	0			103.37
Spectrum 461	68.03	0	0	0.59	0.49	0	0	0	0.48	0	0.55	0	0	0	0.58				29.28	0			107.3
Spectrum 462	67.46	0	0	0.11	0.29	0	0	0.11	0.09	0	31.12	0.26	0	0	0.43				0.13	0			102.93
Spectrum 463	67.67	0	0	0.13	0.11	0	0	0	0.12	0	31.12	0.22	0	0	0.14				0.5	0			106
Spectrum 464	68.39	0	0	0.11	0.19	0	0	0	0.1	0	30.3	0.24	0	0	0.3				0.37	0			107.27
Spectrum 465	65.31	0	0	0.12	17.32	0	0	0	0	0	0	0	0	0	0.2			16.89		0	0.2		96.91
Spectrum 466	68.22	0	0	0.23	0.59	0	0	0.04	0.07	0	29.92	0.23	0	0	0.26				0.44	0			104.34
Spectrum 467	67.63	0	0	0.12	0.17	0	0	0	0	0	31.27	0.17	0	0	0.18				0.47	0			104.48
Spectrum 468	67.69	0	0	0.09	0.24	0	0	0	0	0	31.03	0.18	0	0	0.24				0.53	0			104.58
Spectrum 469	67.89	0	0	0.12	0.25	0	0	0	0.05	0	30.82	0.16	0	0	0.23				0.47	0			105.14
Spectrum 470	68.45	0	0	0.13	0.17	0	0	0	0	0	30.47	0.2	0	0	0.25				0.33	0			105.14
Spectrum 471	63	0.26	0.39	11.46	20.92	0	0	0	3.43	0	0.07	0	0	0	0.47					0			98.88
Spectrum 472	63.89	0.46	0.92	14.31	15.23	0	0	0	3.24	0.04	0.89	0	0	0	1.04					0			97.82
Spectrum 473	65.4	0	0	0.06	34.51	0	0	0	0	0	0	0	0	0	0.03					0			99.9
Spectrum 474	61.78	0.24	0.42	15.21	17.15	0	0	0	4.68	0.05	0.08	0	0	0	0.4					0			93.31
Spectrum 475	65.53	0	0	0.11	34.32	0	0	0	0.03	0	0	0	0	0	0					0			101.14
Spectrum 476	61.47	0.33	0.23	16.11	17.45	0	0	0	4	0.04	0.04	0	0	0.04	0.29					0			91.29
Spectrum 477	64.72	1.62	2.87	14.94	13.42	0	0	0	0	0.1	0.12	0	0	0	2.21					0			94.32

Table A3: EDS analyses for samples TRU19 and TRU20, sorted by phase. All elements were measured. Presented as normalised atomic% with the analytical total in wt% in the right hand column..

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Hf	W	wt% Total
areas																						
TRU19 #389	71.07	1.18	1.58	9.78	8.43	0	0	0	0.1	0.14	0	0	0	0	2.37				5.35			115.41
TRU19 #390	64.28	1.43	1.8	14.54	13.56	0	0	0	0	0.08	0.08	0	0	0.04	4.19				0			92.66
TRU19 #403	69.96	0	0.17	1.23	16.24	0	0	0	0.14	0	0	0	0	0	0.35				11.9			122.27
TRU19 #404	65.28	0	0	0.05	34.63	0	0	0	0	0	0	0	0	0	0.04							97.98
TRU19 #405	68.58	0	0	0.25	0.14	0	0	0	0.36	0.29	0	0	0	0	0.35				30.02			105.3
TRU19 #408	64.2	1.54	2.3	14.27	13.44	0	0	0	0	0.16	0.13	0	0	0	3.91				0.05			92.83
TRU19 #414	64.5	1.5	2.38	14.1	13.41	0.05	0	0	0	0.18	0.13	0	0	0	3.76							93.28
TRU19 #415	71.64	0.64	0.95	5.59	6.94	0	0	0	0.23	0	0	0	0	0	1.2				12.8			120.03
TRU19 #416	68.67	0	0	0.38	0.13	0	0	0	0.42	0	0	0	0	0	0.29				30.12			105.96
TRU19 #417	64.36	1.46	2.23	13.02	15.26	0	0	0	0	0.17	0.11	0	0	0	3.39							92.9
TRU19 #423	72.13	0.47	0.52	3.92	8.68	0	0	0	0.15	0.14	0	0	0	0	1.02				12.98			121.79
TRU20 #427	68.64	0	0	0.23	0.15	0	0	0	0.44	0.26	0	0	0	0	0.18				30.1			106.68
TRU20 #428	69.15	0.15	0.18	1.15	22.22	0	0	0	0.11	0	0	0	0	0	0.43				6.61			123.46
TRU20 #436	64.87	1.36	1.79	14.88	13.31	0	0	0	0	0.08	0.07	0	0	0	3.63							94.87
TRU20 #437	65.57	0	0	0.12	34.25	0	0	0	0	0	0	0	0	0	0.06							100.37
TRU20 #438	68.49	0	0	0.3	0	0	0	0	0.46	0	0	0	0	0	0.27				30.48			107.99
TRU20 #439	64.42	0.35	0.6	7.96	23.74	0	0	0	1.67	0.05	0.45	0	0	0	0.76							100.97
TRU20 #457	63.94	0.27	0.49	8.05	24.27	0	0	0	2.05	0.03	0.26	0	0	0	0.63							100.34
TRU20 #458	65.41	0	0.05	0.41	34.06	0	0	0	0	0	0	0	0	0	0.07							99.76
TRU20 #471	63	0.26	0.39	11.46	20.92	0	0	0	3.43	0	0.07	0	0	0	0.47							98.88
TRU20 #472	63.89	0.46	0.92	14.31	15.23	0	0	0	3.24	0.04	0.89	0	0	0	1.04							97.82
points																						
zircon																						
TRU20 #442	66.73	0	0	0.36	15.56	0.68	0	0	0	0.26	0	0	0	0	0.22			16.07		0.11		94.01
TRU20 #65	65.31	0	0	0.12	17.32	0	0	0	0	0	0	0	0	0	0.2			16.89		0.16		96.91
TRU20 #451	65.03	0	0	0.09	17.43	0	0	0	0	0	0.07	0	0	0	0.13			17.12		0.14		97.65
TRU20 #452	64.6	0	0	0.13	17.62	0	0	0	0.06	0	0	0	0	0	0.14			17.25		0.19		96.02
TRU20 #444	64.76	0	0	0.09	17.46	0	0	0	0.06	0	0	0	0	0	0.1			17.39		0.14		97.65

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Hf	W	wt% Total
tourmaline																						
TRU19 #410	63.9	1.49	2.57	14.02	13.26	0.06	0	0	0	0.18	0.1	0	0	0	4.41				0			92.23
TRU20 #430	64.88	1.49	1.9	14.49	13.27	0	0	0	0	0.1	0.11	0	0	0	3.75							95.36
TRU20 #434	65.41	1.23	1.52	14.68	13.32	0	0	0	0.03	0.08	0.03	0	0	0	3.65				0.05			95.84
TRU19 #402	64.83	1.51	1.45	14.52	13.37	0	0	0	0	0.11	0.03	0	0	0	4.16							96.07
TRU19 #400	64.12	1.64	1.75	14.05	13.38	0	0	0	0	0.16	0.11	0	0	0.03	4.76							91.15
TRU20 #477	64.72	1.62	2.87	14.94	13.42	0	0	0	0	0.1	0.12	0	0	0	2.21							94.32
TRU19 #395	64.15	1.48	1.91	13.97	13.42	0	0	0	0	0.16	0.13	0	0	0	4.77							90.96
TRU19 #411	64.59	1.61	3.43	13.91	13.43	0	0	0.03	0	0.03	0.51	0	0	0	2.47							94.02
TRU20 #433	64.56	1.51	2.35	15.14	13.47	0	0	0	0	0.11	0.05	0	0	0	2.81							94.44
TRU19 #401	64.46	1.74	1.56	14.64	13.5	0	0	0	0	0.05	0	0	0	0.05	4							93.87
TRU19 #421	64.6	1.56	2.26	13.79	13.54	0	0	0	0	0.17	0.19	0	0	0	3.89							95.13
TRU19 #391	64.49	1.56	1.59	14.12	13.56	0	0	0	0	0.13	0.12	0	0	0	4.43							92.69
TRU19 #409	64.39	1.58	1.94	14.16	13.56	0	0	0	0	0.14	0.16	0	0	0	4.07							94.01
TRU19 #412	64.59	1.43	3.39	14.58	13.61	0	0	0	0	0	0.09	0.03	0.03	0	2.24							94.08
TRU19 #397	64.25	1.66	2.09	14.14	13.62	0	0	0	0	0.21	0.04	0	0	0	3.99							93.08
TRU19 #413	64.71	1.16	3.14	14.7	13.68	0	0	0	0	0.03	0.14	0	0.03	0	2.4							93.28
TRU20 #429	64.78	1.37	1.86	14.63	13.69	0	0	0	0	0.1	0.06	0	0	0	3.5							94.2
TRU19 #396	64.3	1.32	0.88	14.56	13.79	0	0	0	0	0.05	0.14	0	0	0	4.96							92.32
TRU19 #399	62.78	1.56	1.57	14.7	13.99	0	0	0	0.03	0.13	0.12	0	0	0	5.13							86.49
TRU20 #435	64.75	1.24	1.55	14.96	14.02	0	0	0	0	0.04	0	0	0	0.04	3.4				0			96.57
mixed?																						
TRU19 #418	65.97	0.3	0.48	3.29	29.06	0	0	0	0	0.04	0	0	0	0	0.87							81.96
TRU19 #425	64.3	1.04	0.74	11.22	19.33	0	0	0	0	0.14	0	0	0	0	3.24							102.58
TRU19 #420	58.11	1.57	2.68	15.86	16.32	0	0	0.19	0	0.25	0.21	0	0	0	4.75				0.06			62.8
rutile																						
TRU20 #440	68.67	0	0	0.1	0.25	0	0	0	0.05	0	29.89	0.25	0	0	0.27				0.43		0.08	108.91
TRU20 #466	68.22	0	0	0.23	0.59	0	0	0.04	0.07	0	29.92	0.23	0	0	0.26				0.44			104.34
TRU20 #456	68.17	0	0	0.13	0.44	0	0	0.05	0	0	29.98	0.19	0	0	0.34				0.7			103.37
TRU20 #464	68.39	0	0	0.11	0.19	0	0	0	0.1	0	30.3	0.24	0	0	0.3				0.37			107.27
TRU20 #445	68.34	0	0	0.1	0.32	0	0	0	0	0	30.42	0.28	0	0	0.2				0.35			105.72
TRU20 #470	68.45	0	0	0.13	0.17	0	0	0	0	0	30.47	0.2	0	0	0.25				0.33			105.14
TRU20 #469	67.89	0	0	0.12	0.25	0	0	0	0.05	0	30.82	0.16	0	0	0.23				0.47			105.14

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Hf	W	wt% Total
TRU20 #454	67.82	0	0	0.18	0.17	0	0	0	0	0	30.99	0.21	0	0	0.17				0.46			103.63
TRU20 #468	67.69	0	0	0.09	0.24	0	0	0	0	0	31.03	0.18	0	0	0.24				0.53			104.58
TRU20 #455	68.07	0	0	0.12	0.09	0	0	0	0	0	31.11	0.22	0	0	0.17				0.22			105.41
TRU20 #460	67.51	0	0	0.13	0.28	0	0	0	0	0	31.12	0.22	0	0	0.27				0.47			103.37
TRU20 #462	67.46	0	0	0.11	0.29	0	0	0.11	0.09	0	31.12	0.26	0	0	0.43				0.13			102.93
TRU20 #463	67.67	0	0	0.13	0.11	0	0	0	0.12	0	31.12	0.22	0	0	0.14				0.5			106
TRU20 #467	67.63	0	0	0.12	0.17	0	0	0	0	0	31.27	0.17	0	0	0.18				0.47			104.48
TRU20 #446	65.07	0	0	0.18	0.44	0	0	0	0	0.16	33.67	0.25	0	0	0.23							97.33
TRU20 #443	65.79	0	0.17	5.06	6.32	0	0	0	2.09	0.12	19.94	0.19	0	0	0.33							90.42
cassiterite																						
TRU19 #407	68.03	0	0	0.3	0	0	0	0	0.28	0.29	0	0	0	0	1.01				30.09			106.98
TRU19 #406	68.48	0	0	0.32	0	0	0	0	0.36	0	0	0	0	0	0.61				30.22			107.02
TRU20 #453	68.59	0	0	0.4	0.2	0	0	0	0.37	0	0	0	0	0	0.2				30.13			107.5
TRU20 #426	67.56	0	0	0.27	0.16	0	0	0	0.38	0	0	0	0	0	0.12				31.51			104.64
TRU20 #447	67.42	0	0	0.31	0.26	0	0	0	0.4	0	0.31	0	0	0	0.33				30.98			106.38
TRU20 #450	68.33	0	0	0.32	0.37	0	0	0	0.4	0	0.43	0	0	0	0.52				29.64			107.42
TRU20 #441	60.73	0	0	0.4	0.19	0	0	0	0.44	0.53	0.3	0	0	0	0.37				37.03			94.45
TRU20 #459	67.82	0	0	0.31	0.2	0	0	0	0.44	0	0.32	0	0	0	0.3				30.61			106.19
TRU20 #461	68.03	0	0	0.59	0.49	0	0	0	0.48	0	0.55	0	0	0	0.58				29.28			107.3
TRU20 #448	67.72	0	0	0.29	0.14	0	0	0	0.5	0	0.6	0	0	0	0.31				30.43			106.59
muscovite																						
TRU20 #476	61.47	0.33	0.23	16.11	17.45	0	0	0	4	0.04	0.04	0	0	0.04	0.29							91.29
TRU20 #474	61.78	0.24	0.42	15.21	17.15	0	0	0	4.68	0.05	0.08	0	0	0	0.4							93.31
quartz																						
TRU19 #424	65.87	0	0	0	33.93	0	0.04	0	0	0.09	0	0	0	0	0.06							98.99
TRU20 #449	65.64	0	0	0.13	34.19	0	0	0	0	0	0	0	0	0	0.04							96.89
TRU20 #475	65.53	0	0	0.11	34.32	0	0	0	0.03	0	0	0	0	0	0							101.14
TRU20 #473	65.4	0	0	0.06	34.51	0	0	0	0	0	0	0	0	0	0.03							99.9
TRU20 #432	65.44	0	0	0	34.53	0	0	0	0	0	0	0	0	0	0.03							99.96
TRU19 #398	65.4	0	0	0	34.57	0	0	0	0	0	0	0	0	0	0.04							97.69
TRU20 #431	65.39	0	0	0	34.58	0	0	0	0	0	0	0	0	0	0.03							99.97
TRU19 #419	65.1	0	0	0.11	34.65	0	0	0	0	0	0	0	0	0	0.14							99.61

Spectrum Label	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Cu	As	Zr	Sn	Hf	W	wt% Total
TRU19 #393	65.18	0	0	0	34.82	0	0	0	0	0	0	0	0	0	0							97.81
TRU19 #422	65.1	0	0	0	34.83	0	0	0	0	0	0	0	0	0	0.07							99.13
TRU19 #394	65.1	0	0	0	34.84	0	0	0	0	0	0	0	0	0	0.05							98.52
arsenopyrite																						
TRU19 #392	17.07	0.5	0	0	0.17	0	26.94	0	0	0	0	0	0	0	26.13	0	28.93		0.26			104.41

Table A4: EDS analyses for analytical standards.

Day 1

	O	Mg	Si	Fe	Ni	Total
Olivine std	44.09	30.74	19.45	5.64	0.29	100.21
Spectrum 17	42.54	29.85	18.61	5.43	0.51	96.95
Spectrum 18	42.12	29.6	18.37	5.49	0.5	96.07
Spectrum 19	42.53	29.9	18.57	5.47	0.48	96.95
deviation	-0.04	-0.03	-0.04	-0.04	0.76	
	-0.04	-0.04	-0.06	-0.03	0.72	
	-0.04	-0.03	-0.05	-0.03	0.66	

	O	Mg	Al	Si	Ca	Ti	Cr	Mn	Fe	Total
Pyrope std	44.38	12.27	11.42	19.37	3.11	0.3	1.41	0.24	6.81	99.42
Spectrum 47	44.77	12.55	11.3	19.68	2.96	0.35	1.18	0.26	6.99	100.03
Spectrum 50	44.71	12.51	11.32	19.63	2.96	0.36	1.15	0.3	7.01	99.95
Spectrum 51	44.56	12.41	11.29	19.61	2.96	0.35	1.15	0.28	6.93	99.54
deviation	0.01	0.02	-0.01	0.02	-0.05	0.17	-0.16	0.08	0.03	
	0.01	0.02	-0.01	0.01	-0.05	0.20	-0.18	0.25	0.03	
	0.00	0.01	-0.01	0.01	-0.05	0.17	-0.18	0.17	0.02	

Day 3

Olivine Std	O	Mg	Si	Fe	Ni	Total
Olivine std	44.09	30.74	19.45	5.64	0.29	100.21
Spectrum 111	44.65	31.17	19.68	5.68	0.33	101.51
Spectrum 112	44.66	31.16	19.68	5.69	0.37	101.55
Spectrum 113	44.65	31.19	19.67	5.66	0.36	101.53
deviation	0.01	0.01	0.01	0.01	0.14	
	0.01	0.01	0.01	0.01	0.28	
	0.01	0.01	0.01	0.00	0.24	

Appendix B:

Locations of microanalyses and other SEM images

Archive Plate Captions

Archive plates are arranged so that the left-hand column in each plate contains backscattered electron images, with the corresponding secondary electron image and EDS microanalysis details are presented in the adjacent right-hand column as appropriate.

Plate A1: Sample TRU19
Mosaic of backscattered electron images, showing most of the mounted sample.

Plate A2: Sample TRU19
a. Site 747, backscattered electron image.
b. Site 772, secondary electron image and EDS microanalysis locations.
c. Site 748, backscattered electron image.
d. Site 773, secondary electron image and EDS microanalysis locations.

Plate A3: Sample TRU19
a. Site 749, backscattered electron image.
b. Site 774, secondary electron image and EDS microanalysis locations.
c. Site 750, backscattered electron image.
d. Site 775, secondary electron image and EDS microanalysis locations.

Plate A4: Sample TRU19
a. Site 751, backscattered electron image.
b. Site 777, secondary electron image and EDS microanalysis locations.
c. Site 752, backscattered electron image.

Plate A5: Sample TRU19
a. Site 753, backscattered electron image.
b. Site 778, secondary electron image and EDS microanalysis locations.

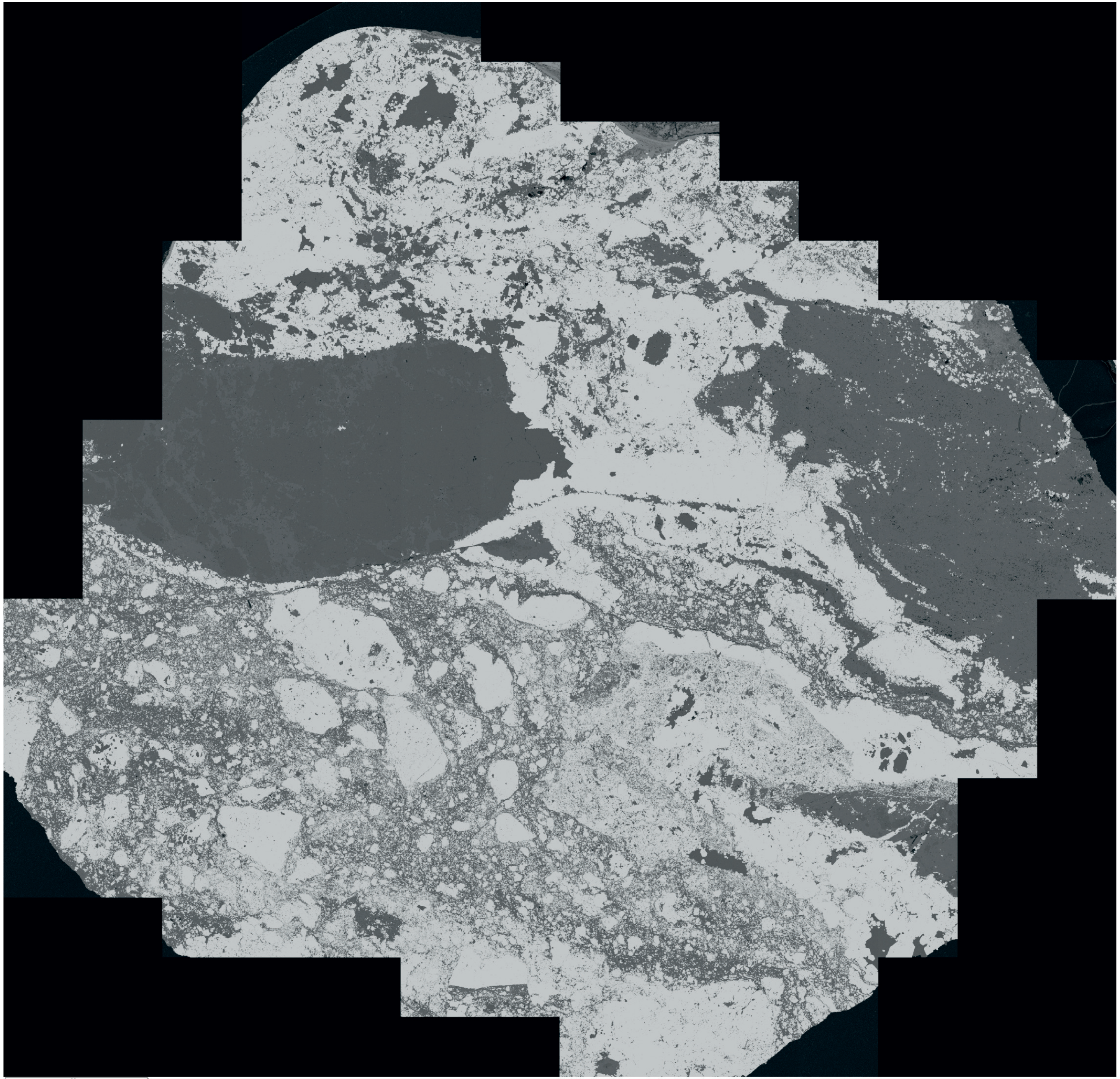
Plate A6: Sample TRU20
Mosaic of backscattered electron images, showing most of the mounted sample.

Plate A7: Sample TRU20
a. Site 754, backscattered electron image.
b. Site 779, secondary electron image and EDS microanalysis locations.
c. Site 755, backscattered electron image.
d. Site 780, secondary electron image and EDS microanalysis locations.

Plate A8: Sample TRU20
a. Site 756, backscattered electron image.
b. Site 781, secondary electron image and EDS microanalysis locations.

Plate A9: Sample TRU21
Mosaic of backscattered electron images, showing most of the mounted sample.

Plate A1



5mm

Plate A2

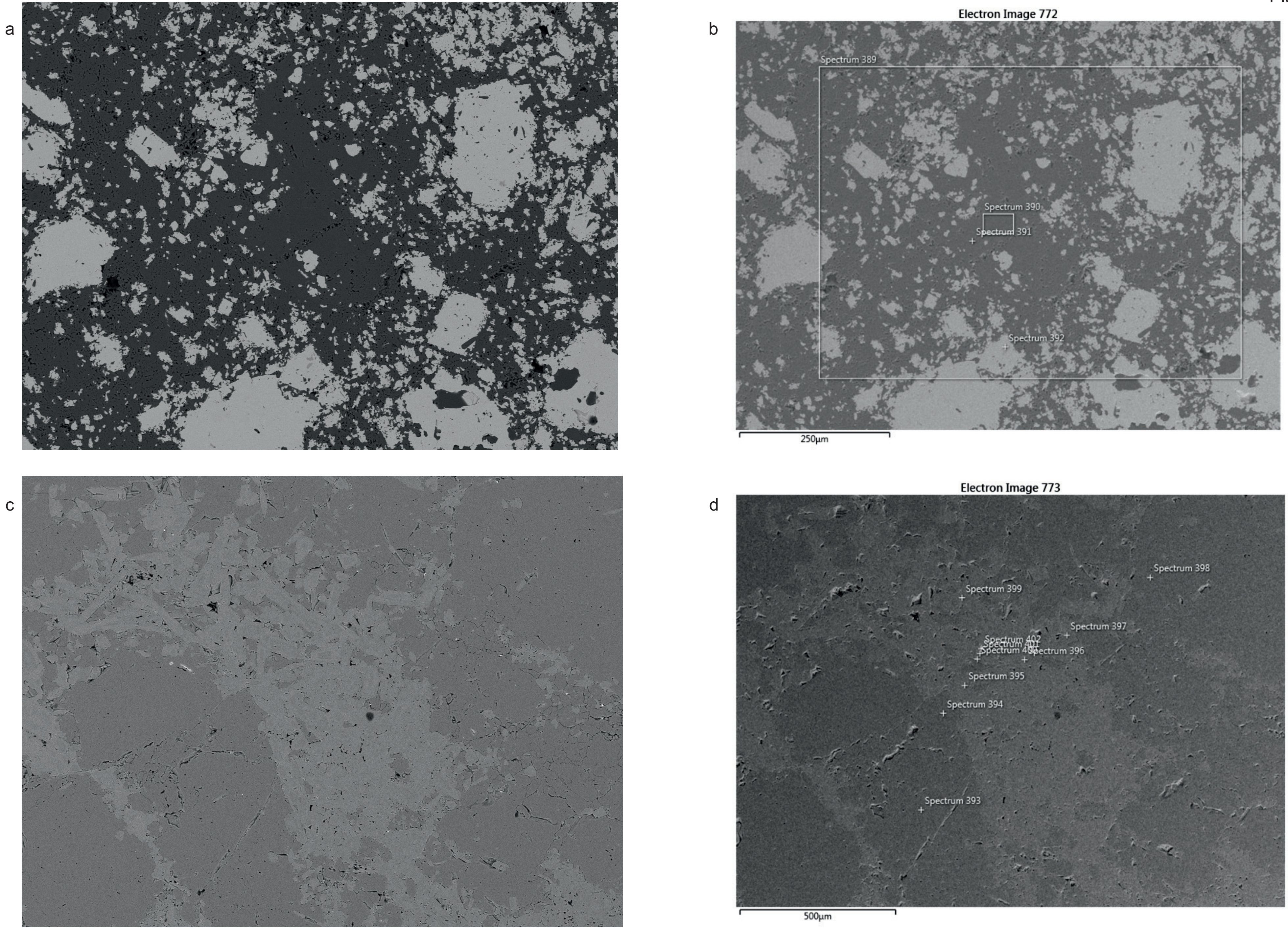
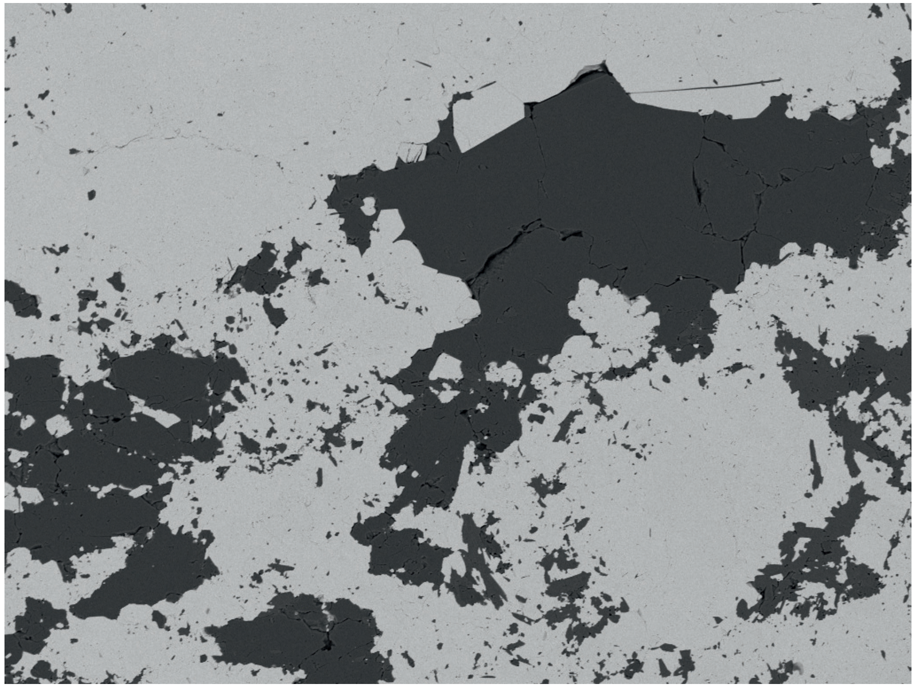

a
b
Electron Image 772
Spectrum 389
Spectrum 390
Spectrum 391
Spectrum 392
250µm
c
d
Electron Image 773
Spectrum 398
Spectrum 399
Spectrum 397
Spectrum 396
Spectrum 395
Spectrum 394
Spectrum 393
500µm

Plate A3

a



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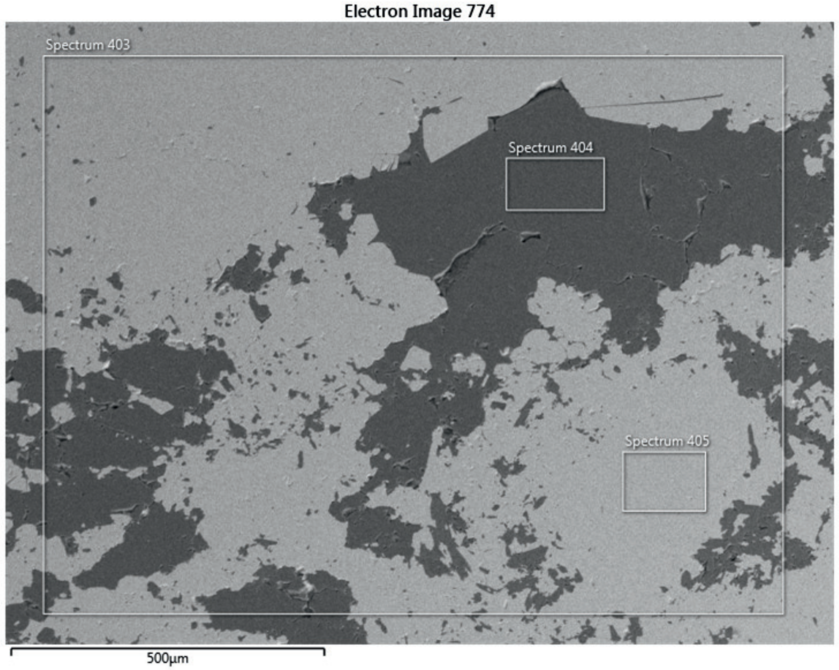

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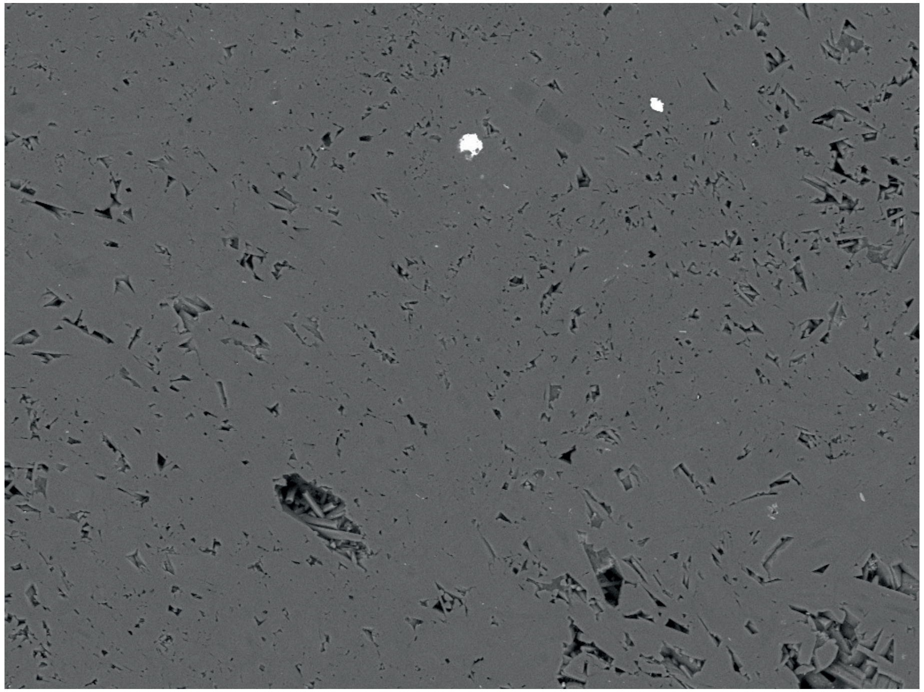

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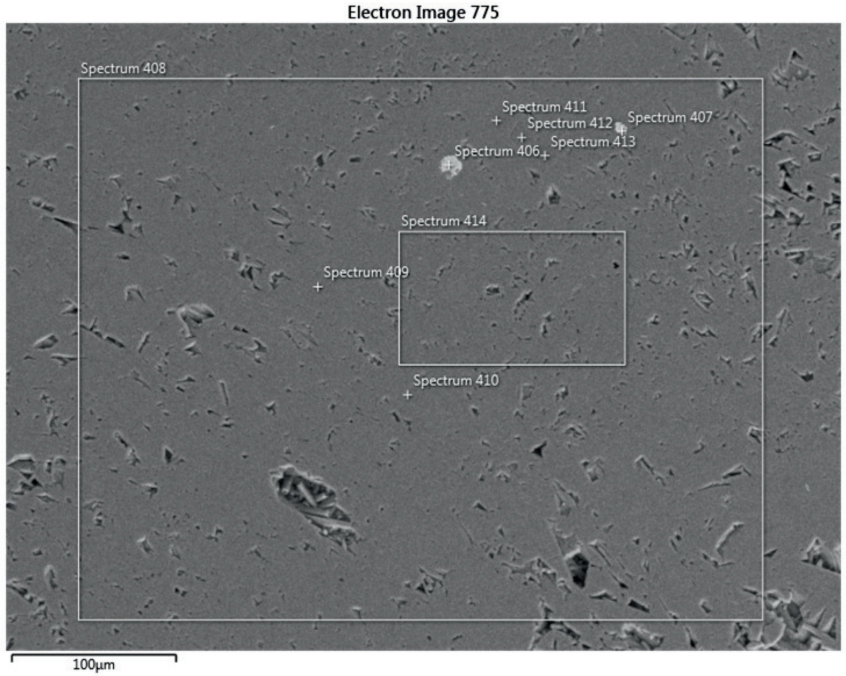
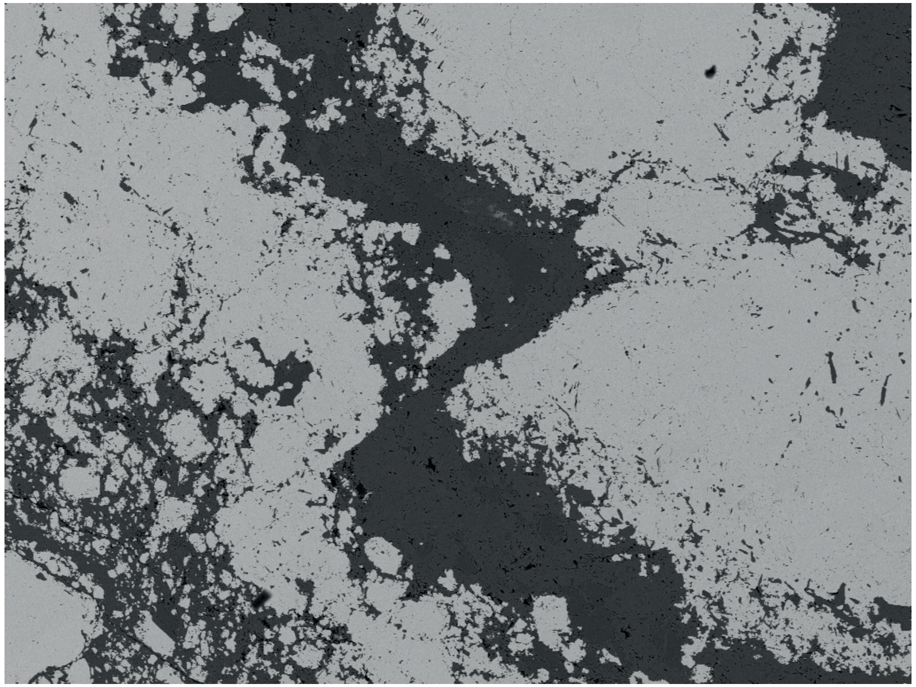
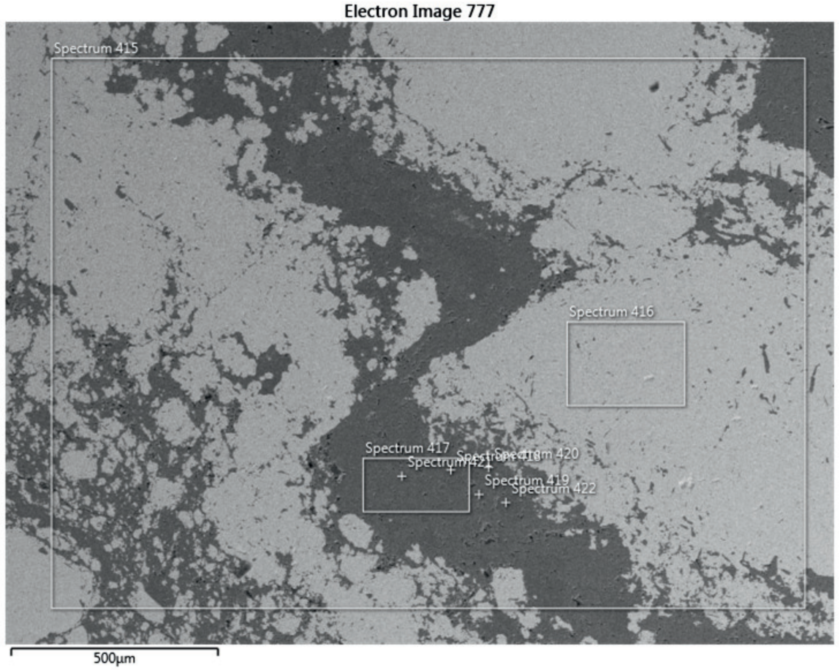


Plate A4

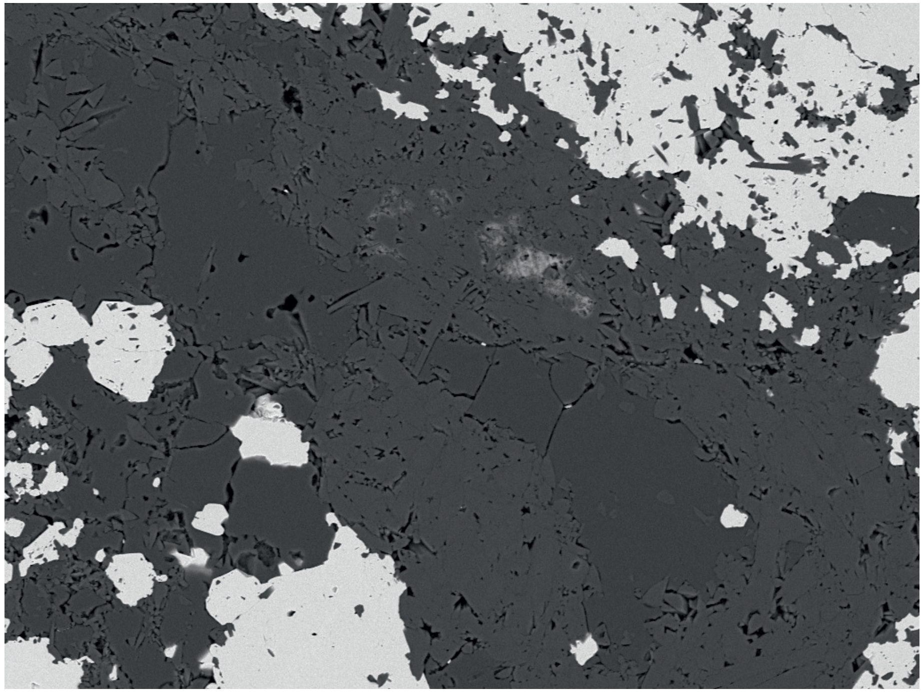
a



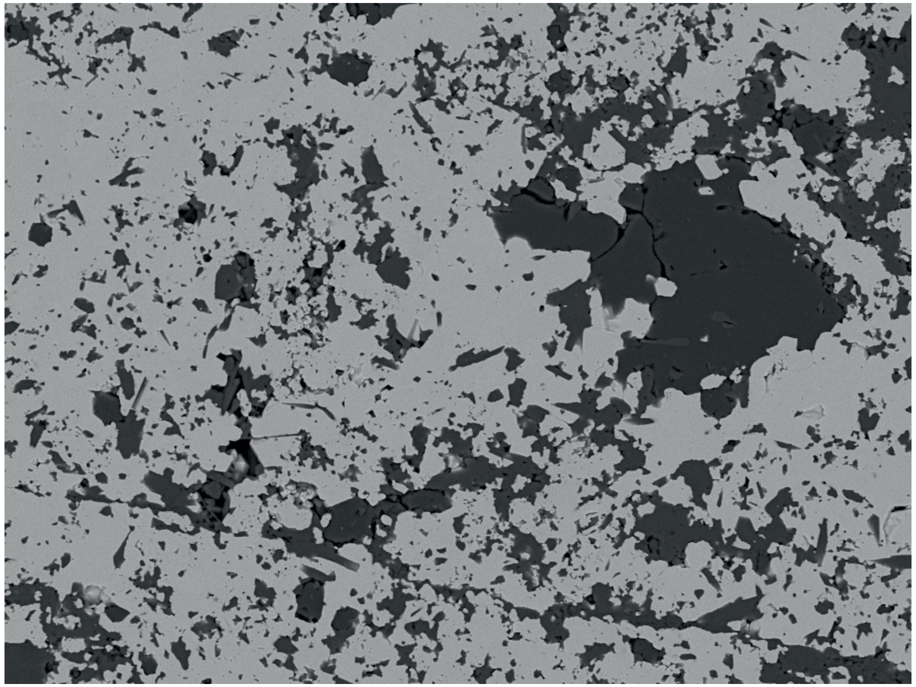
b

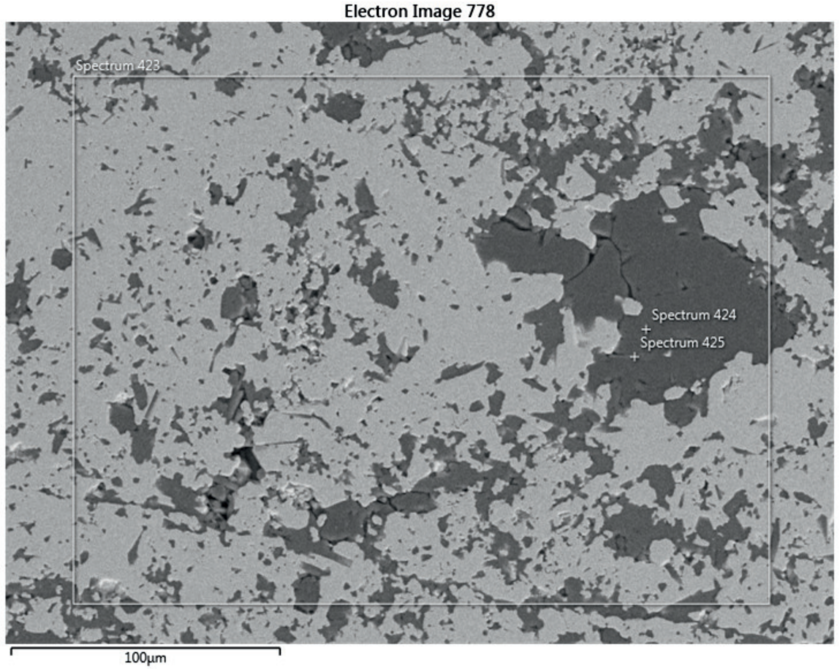

Electron Image 777
Spectrum 415
Spectrum 416
Spectrum 417
Spectrum 421
Spectrum 420
Spectrum 419
Spectrum 422
500µm

c



a




Electron Image 778
Spectrum 423
Spectrum 424
Spectrum 425
100µm

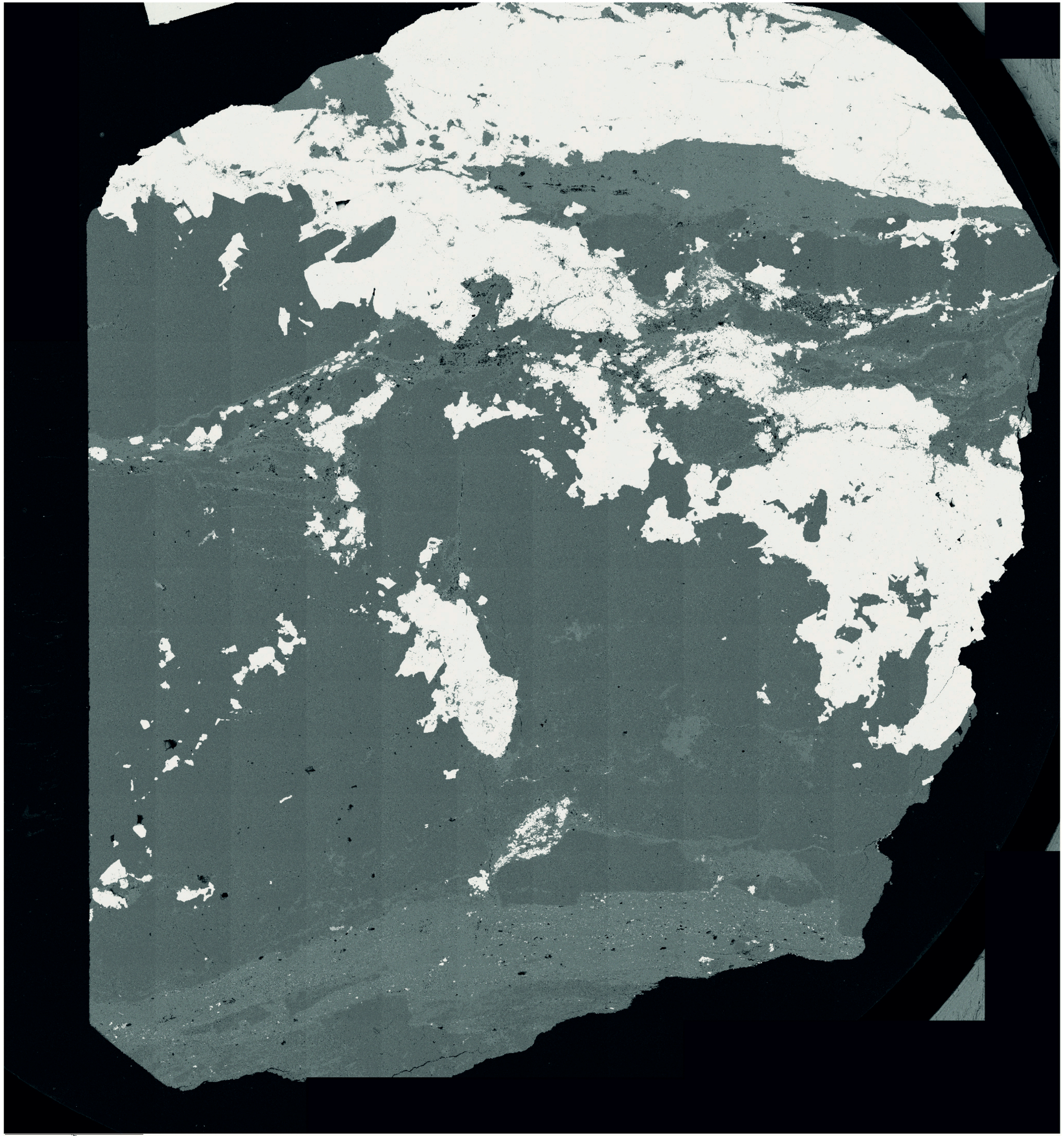

5mm

Plate A7

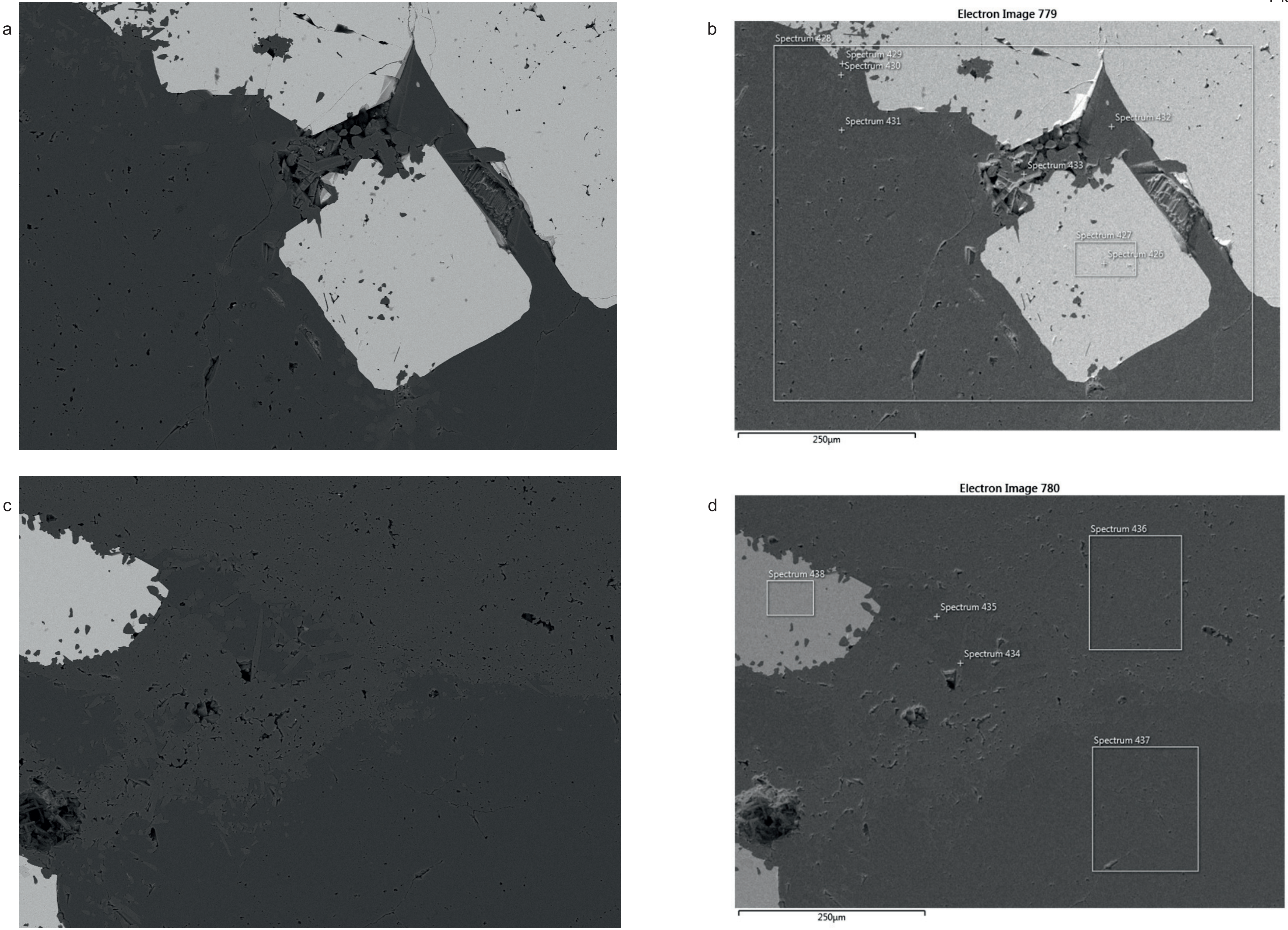
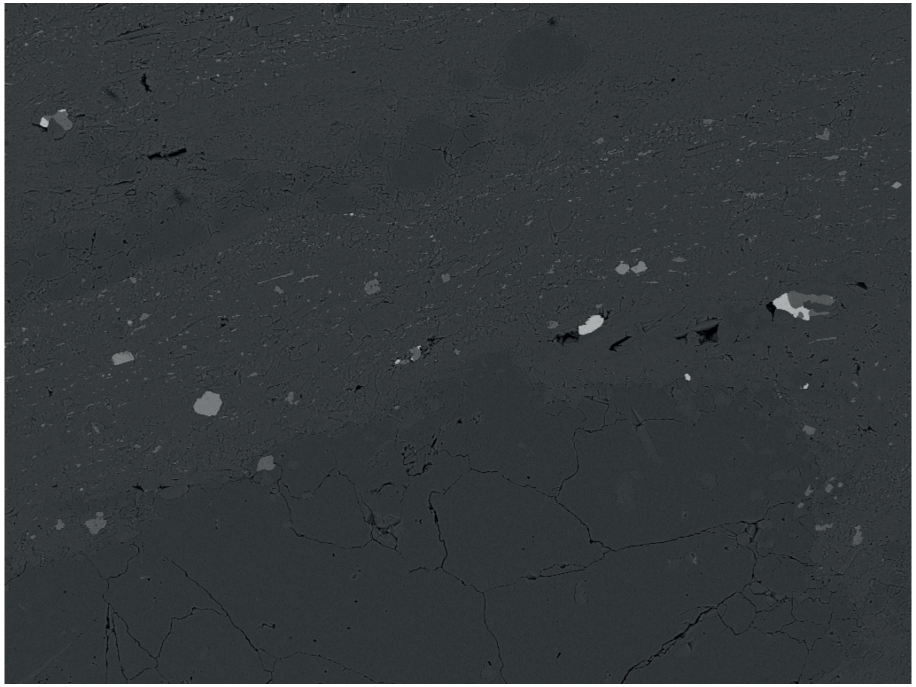
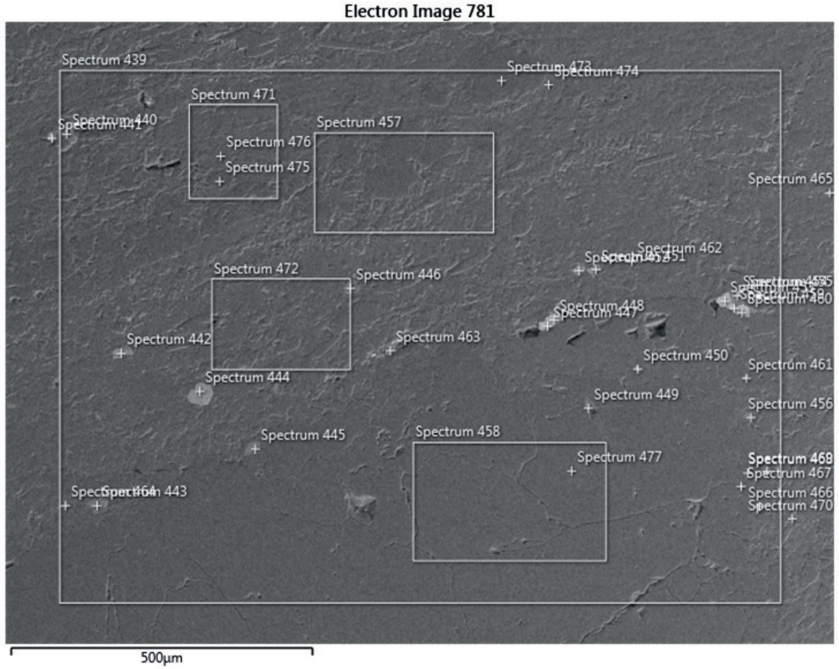

a
b
Electron Image 779
Spectrum 428
Spectrum 429
Spectrum 430
Spectrum 431
Spectrum 432
Spectrum 433
Spectrum 427
Spectrum 426
250µm
c
d
Electron Image 780
Spectrum 436
Spectrum 438
Spectrum 435
Spectrum 434
Spectrum 437
250µm

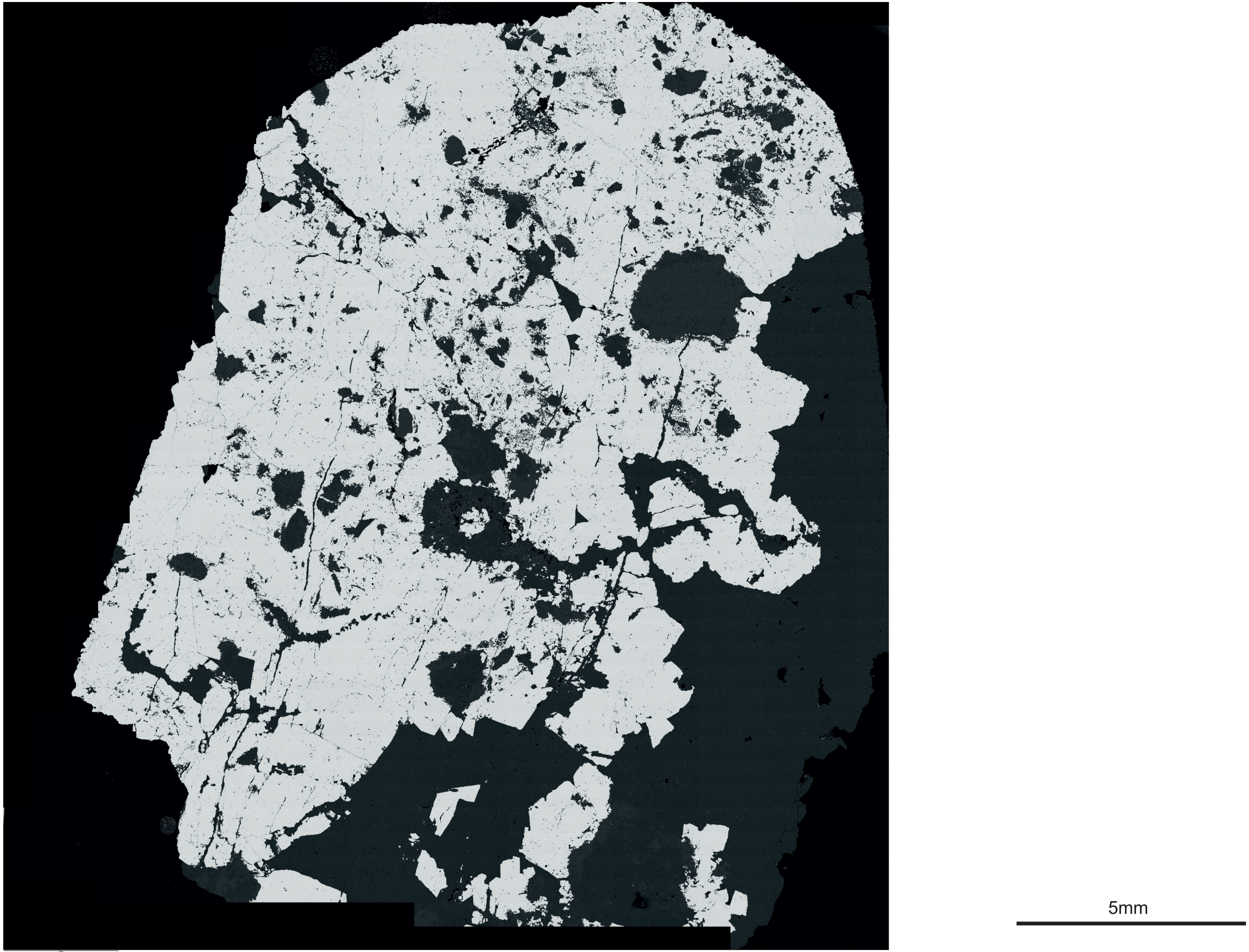
Plate A8

a



b


Electron Image 781
Spectrum 439
Spectrum 474
Spectrum 471
Spectrum 457
Spectrum 476
Spectrum 475
Spectrum 465
Spectrum 462
Spectrum 472
Spectrum 446
Spectrum 448
Spectrum 442
Spectrum 463
Spectrum 450
Spectrum 461
Spectrum 444
Spectrum 449
Spectrum 456
Spectrum 445
Spectrum 458
Spectrum 477
Spectrum 467
Spectrum 466
Spectrum 470
Spectrum 443
500µm


5mm

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