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Micro analytical observation of elemental distribution in arbuscular mycorrhizal (AM) roots from mining sites in South Africa and identification of their AM fungi

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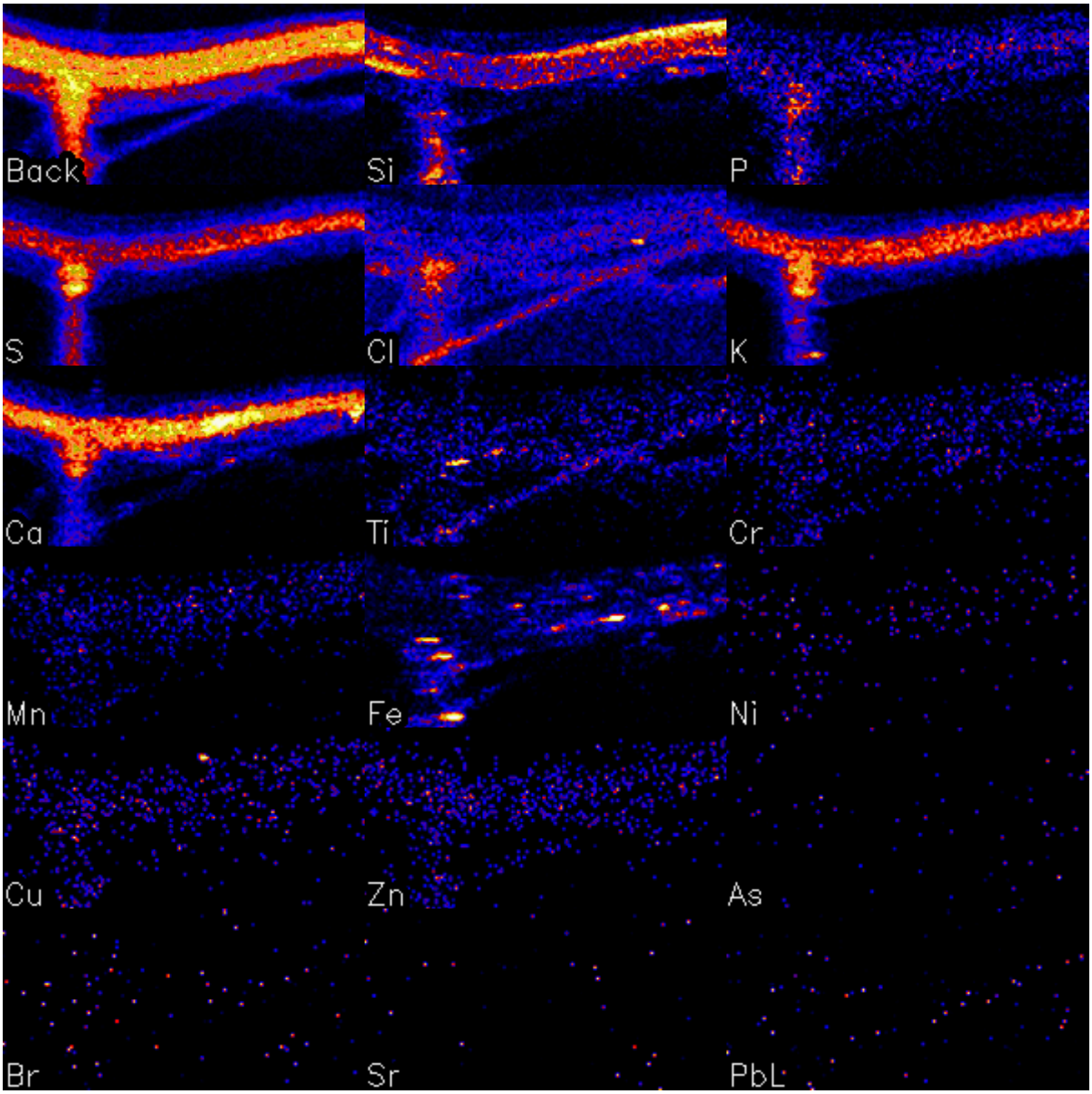
Appendix 1

Elemental Maps

1. **Use images from CGM and delete html.**
2. **All pictures to go to the appendix**
3. **Results to show the regions measured**
4. **as well as comparisons**
5. **For result description see Carol's PIXE chapter**
6. **Control??**

1. zamx_w290_4-regions-PIXE, WW14 8a North West (West Wits) high Au +Ur).

File Name: zamx_w290_4.evt,
Dynamic Matrix: zamx_w290_4q0.dam
Charge: 1568 µC
Scan: X= 834 µm, Y= 423 µm
Pixel: X size: 128, Y Size: 64



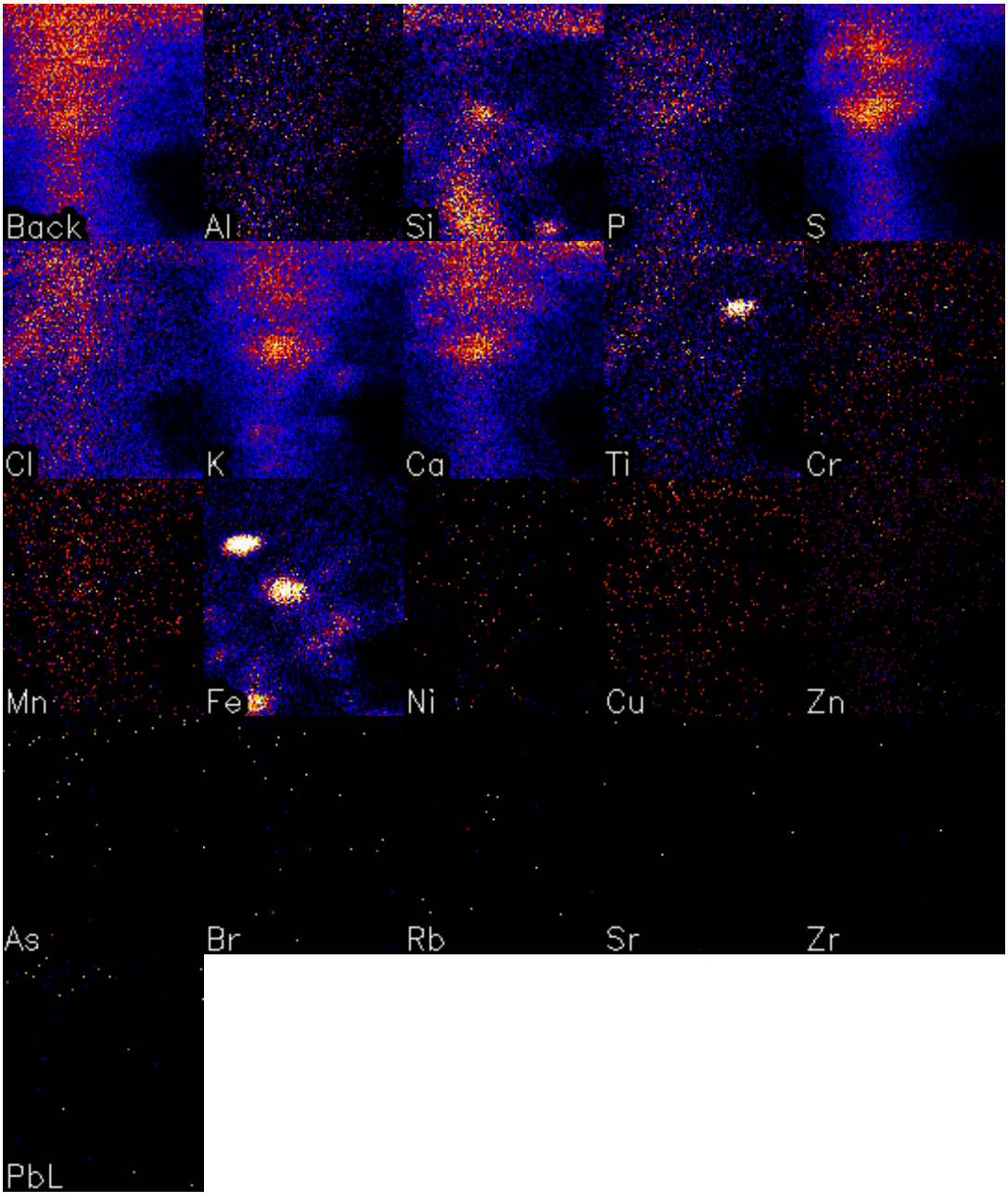
Relative Concentration Legend

Zero Maximum

Fig 3.5.7: zamx_w290_4-regions-PIXE, WW14 8a North West (West Wits) high Au +U). In this sample, Cl, Fe, K, Ca, Ti, Si, and P were localized in both the root and the external Hyphae.

2. zamx_w290_6-regions-PIXE, WW14 8a, North West (West Wits) high Au +Ur).

File Name: zamx_w290_6.evt,
Dynamic Matrix: zamx_w290_6q0.dam
Charge: 651 µC
Scan: X= 143 µm, Y= 167 µm
Pixel: X size: 108, Y Size: 128



Relative Concentration Legend

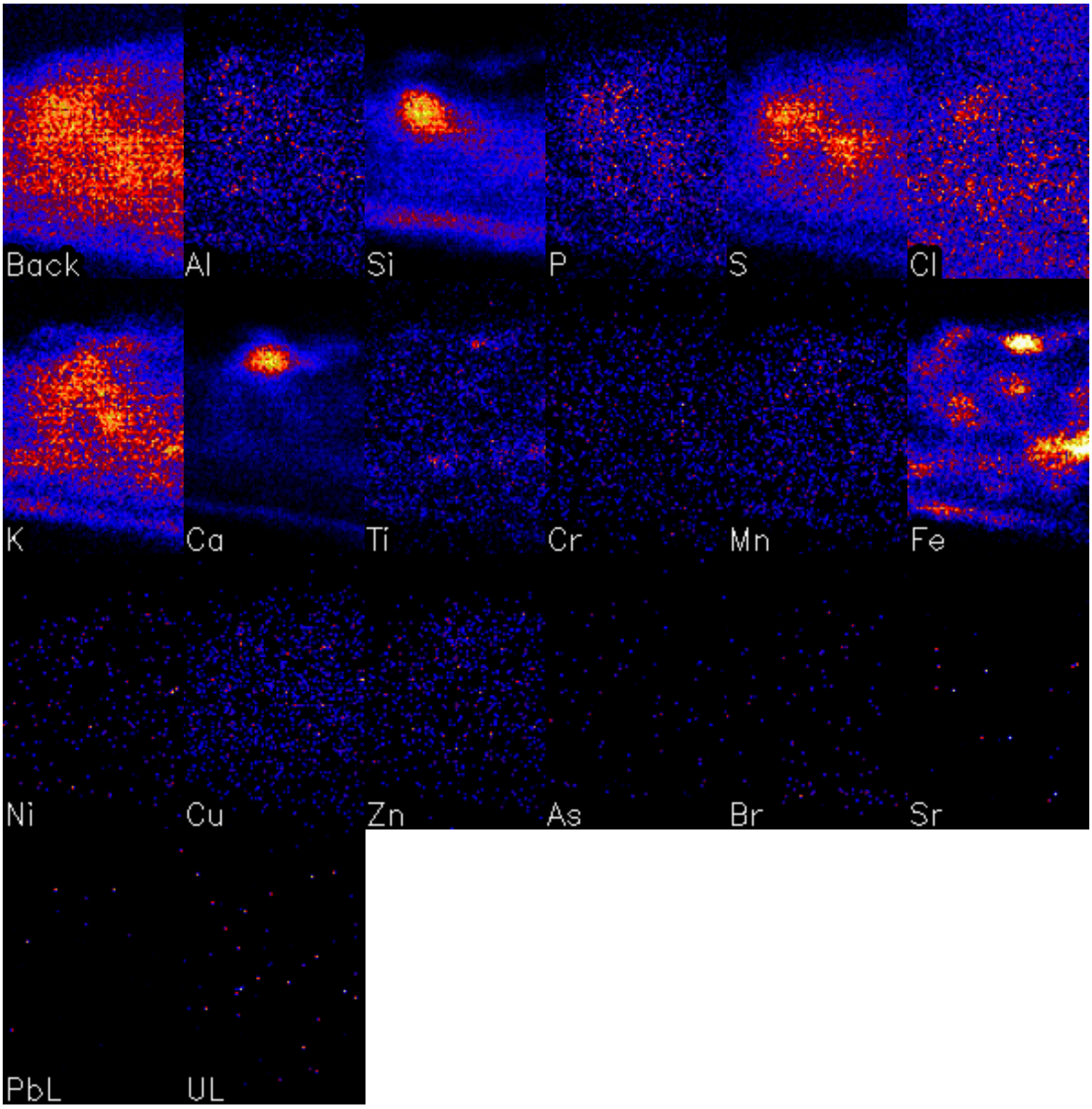


Fig 3.5.8: zamx_w290_6-regions-PIXE, WW14 8a, North West (West Wits) high Au +Ur). Fe, K, Ca, Ti, S and Si were localized in the root AMF Vesicles with Fe

extensively expressed as compared to other elements. These correlate with the elemental concentration shown on the **table 1** (insert Pictures).

3. D1 (MP) 5 East Rand (ER)Metallurgical Plant (MP) Regions 0 -3 (zamx_w290_7-regions-PIXE).

File Name: zamx_w290_7.evt
Dynamic Matrix: zamx_w290_7q0.dam
Charge: 769 µC
Scan: X= 110 µm, Y= 167 µm
Pixel: X size: 84, Y Size: 128



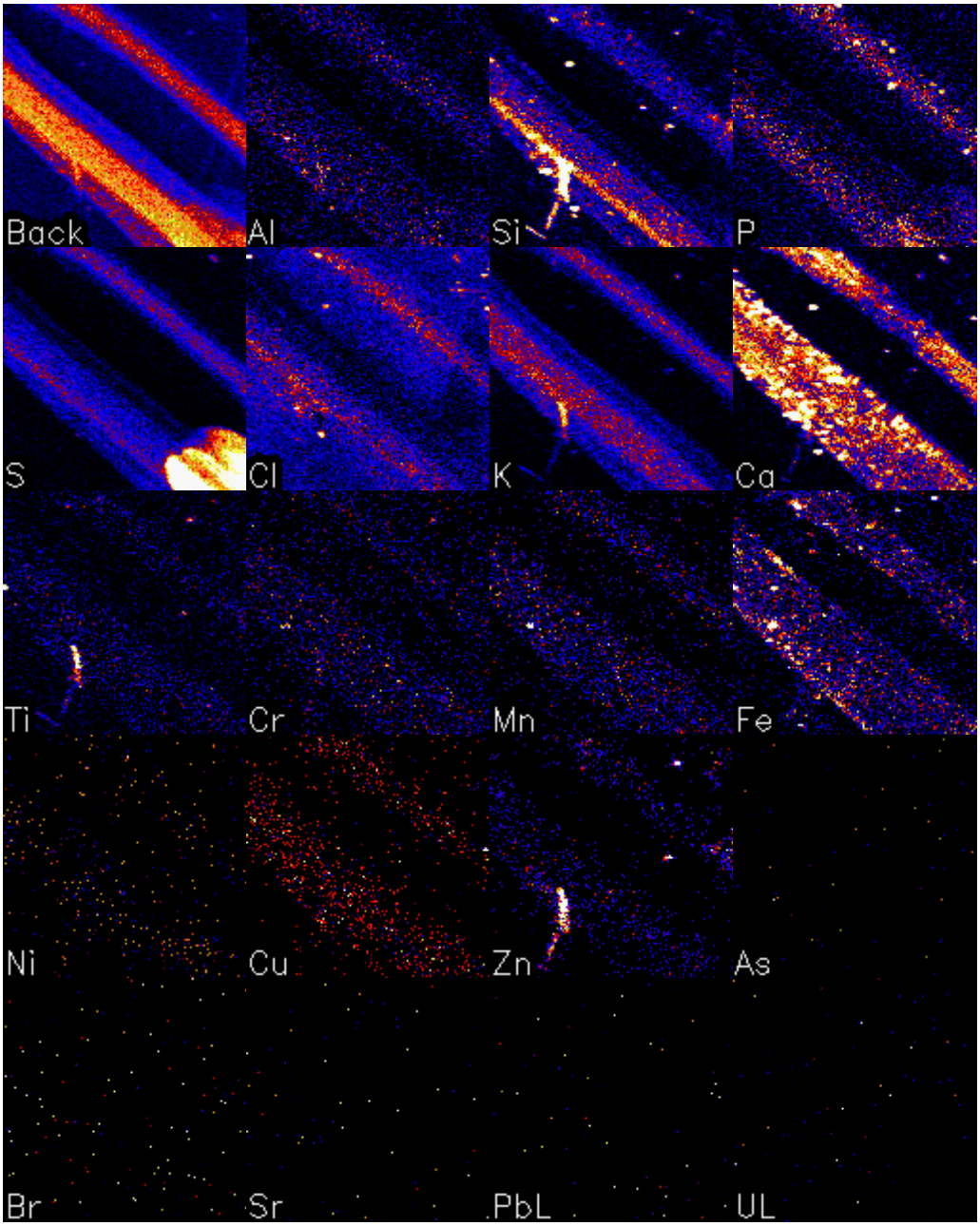
Relative Concentration Legend

Zero  Maximum

Fig 3.5.9: D1 (MP) 5 East Rand (ER)Metallurgical Plant (MP) Regions 0 -3 (zamx_w290_7-regions-PIXE). Ca, Fe, K, S, Ti and Si were localized in the root AMF Vesicles with Fe extensively expressed as compared to other elements.

4. (M15 A2) North West (Vaal Reefs) Au +Ur) Regions 0 -4 (zamx_w290_8-regions-PIXE).

File Name: zamx_w290_8.evt
Dynamic Matrix: zamx_w290_8q0.dam
Charge: 3656 µC
Scan: X= 667µm, Y= 668 µm
Pixel: X size: 128, Y Size: 128



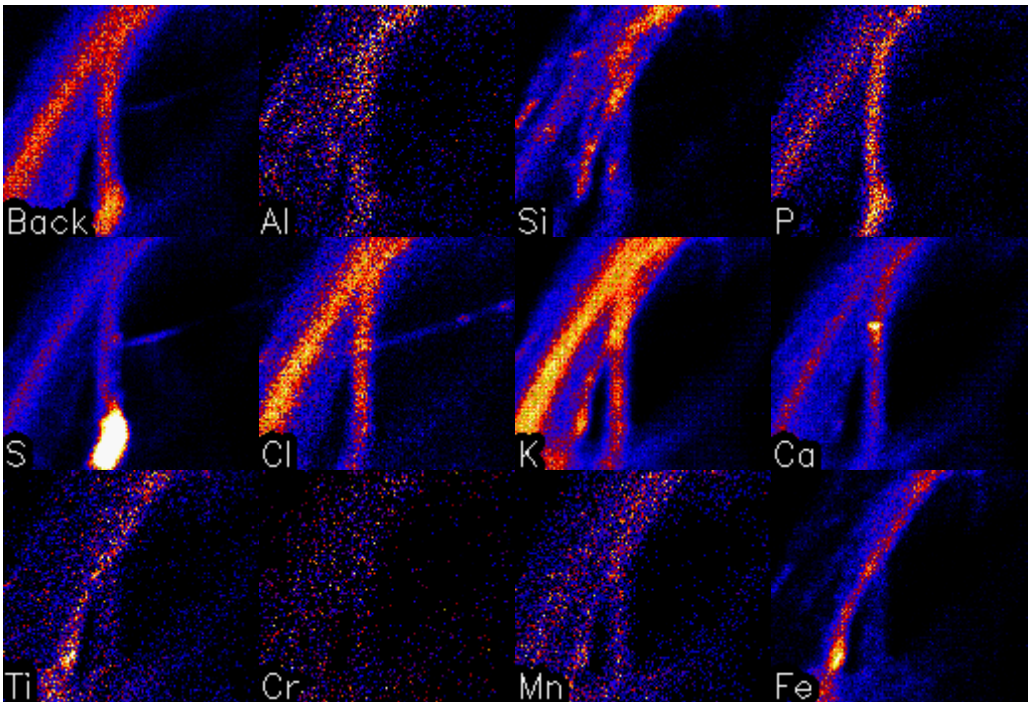
Relative Concentration Legend

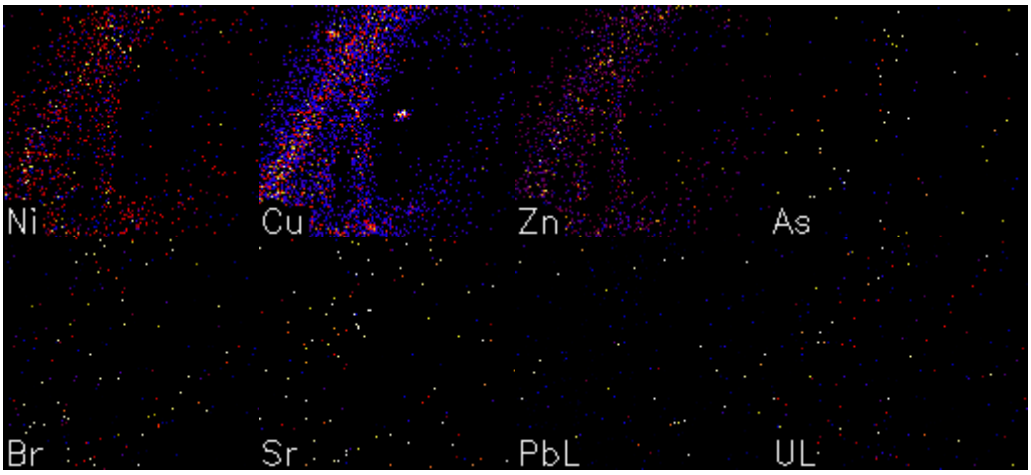
Zero  Maximum

Fig 3.5.10: (M15 A2) North West (Vaal Reefs) Au +Ur) Regions 0 -4 (zamx_w290_8-regions-PIXE). Ca, Cl, Fe, K, P, Si, Zn and Ti, were localized in both roots and Hyphae with Fe and Ca extensively expressed as compared to other elements. Zn, Si, K and Ti were extensively expressed in Hyphae more than in roots itself.

5. Ctr + Myco 8 R1 Rem (Regions 0 -3) (zamx_w290_9-regions-PIXE).

File Name: zamx_w290_9.evt
Dynamic Matrix: zamx_w290_9q0.dam
Charge: 1705 µC
Scan: X= 417 µm, Y= 382 µm
Pixel: X size: 128, Y Size: 116





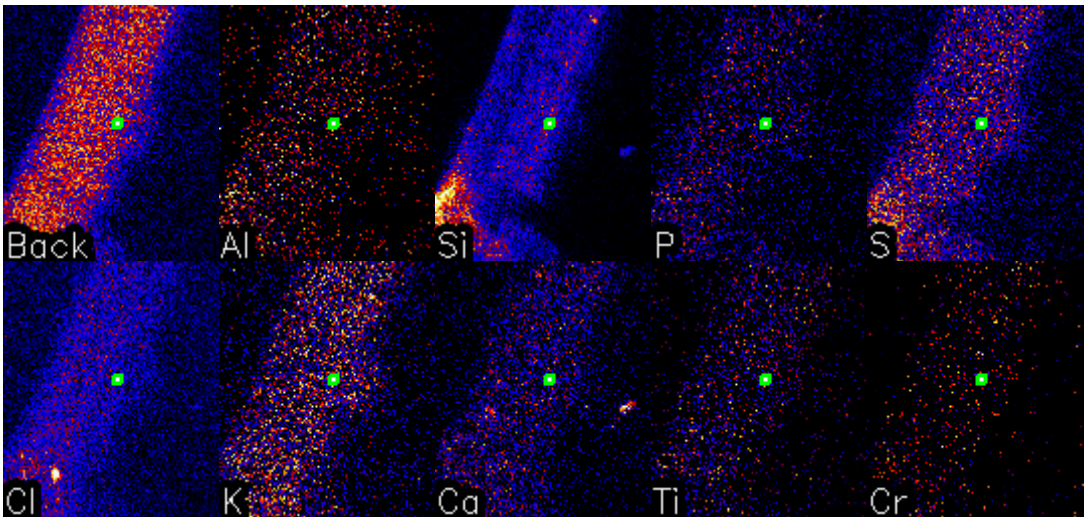
Relative Concentration Legend

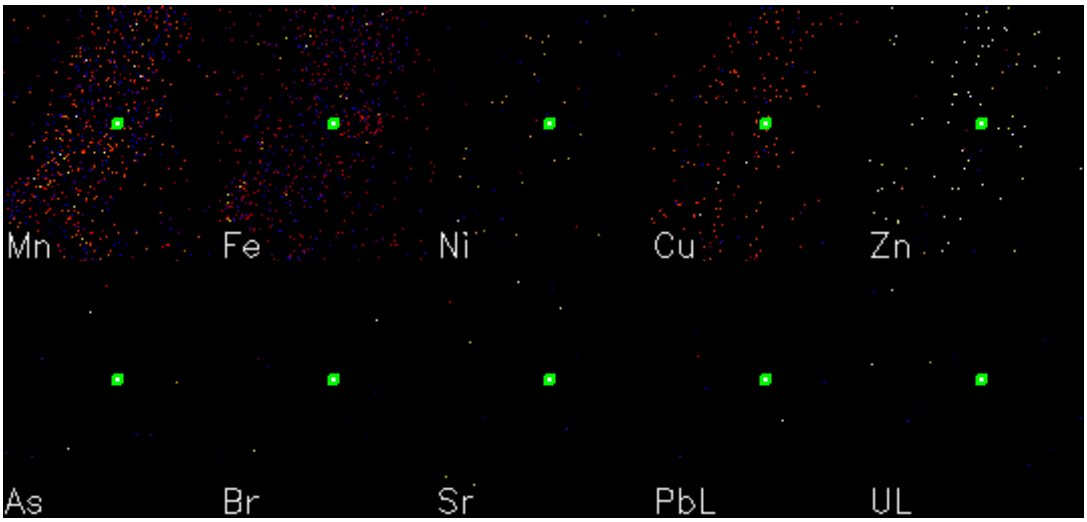


Fig 3.5.11: Ctr + Myco 8 R1 Rem (Regions 0 -3) (zamx_w290_9-regions-PIXE). Al, Ca, Cl, Fe, K, P, Si, Cu Mn, Zn, and Ti, were localized in both roots and Hyphae with Cl and K extensively expressed as compared to other elements. Cu and Ti were extensively expressed in AMF structures more than in roots itself.

6. Ctr + Nu R2 (4) (zamx_w295_10-regions-PIXE).

File Name: zamx_w295_10.evt
Dynamic Matrix: zamx_w295_10q0.dam
Charge: 459 µC
Scan: X= 215 µm, Y= 251 µm
Pixel: X size: 108, Y Size: 128





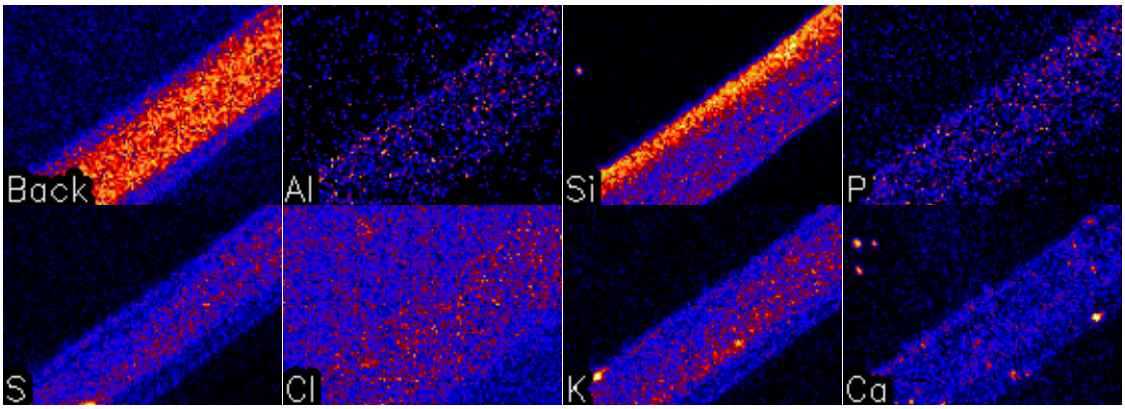
Relative Concentration Legend

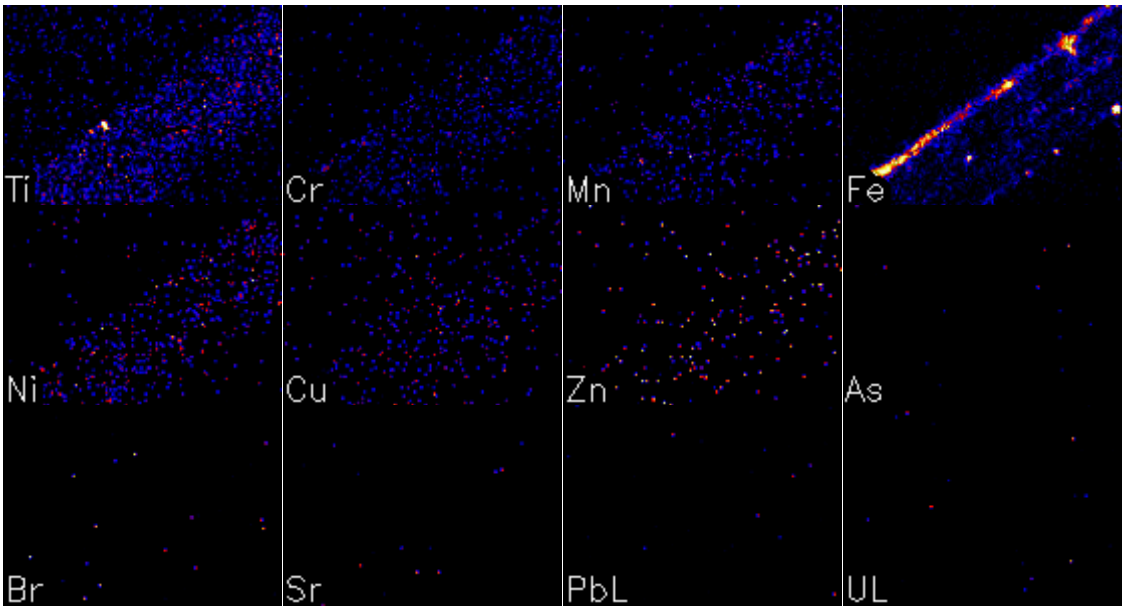


Fig 3.5.12: Ctr + Nu R2 (4) (**zamx_w295_10-regions-PIXE)**. Al, Ca, Cl, and Si were localized in AMF roots in low amount. This is a control with no spores and elements added. Eragrostis grass was grown in Zeolite and nutrient solution only. Thus less or not elemental concentration is expected.

7. Gauteng Egness Mine ABB5 R2 (5) (zamx_w295_11-regions-PIXE).

File Name: zamx_w295_11.evt
Dynamic Matrix: zamx_w295_11q0.dam
Charge: 698 µC
Scan: X= 250 µm, Y= 180 µm
Pixel: X size: 128, Y Size: 92





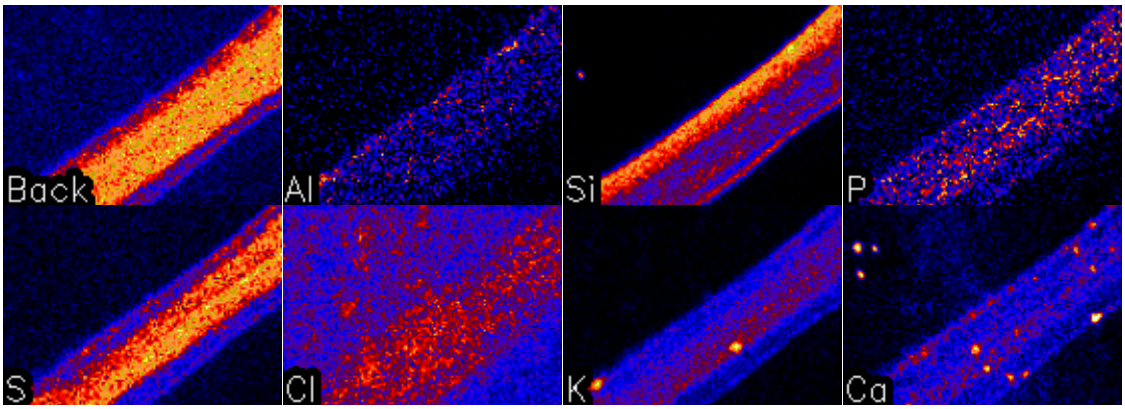
Relative Concentration Legend

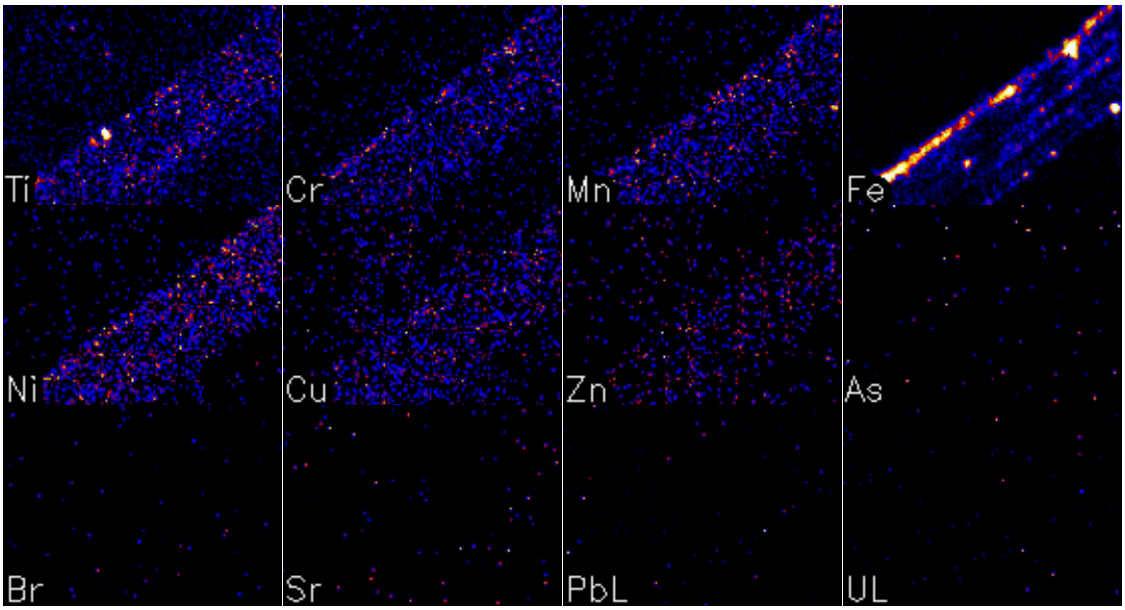


Fig 3.5.13: Gauteng Egness Mine ABB5 R2 (5) (zamx_w295_11-regions-PIXE). Ca, Fe, K, Si, and Ti, were localized in AMF roots with low concentration. Ti and Ca appear to be in low concentration on the elemental maps.

8. Gauteng Egness Mine ABB5 R2 (5) (zamx_w295_12-regions-PIXE).

File Name: zamx_w295_12.evt
Dynamic Matrix: zamx_w295_12q0.dam
Charge: 2369 µC
Scan: X= 250 µm, Y= 180 µm
Pixel: X size: 128, Y Size: 92





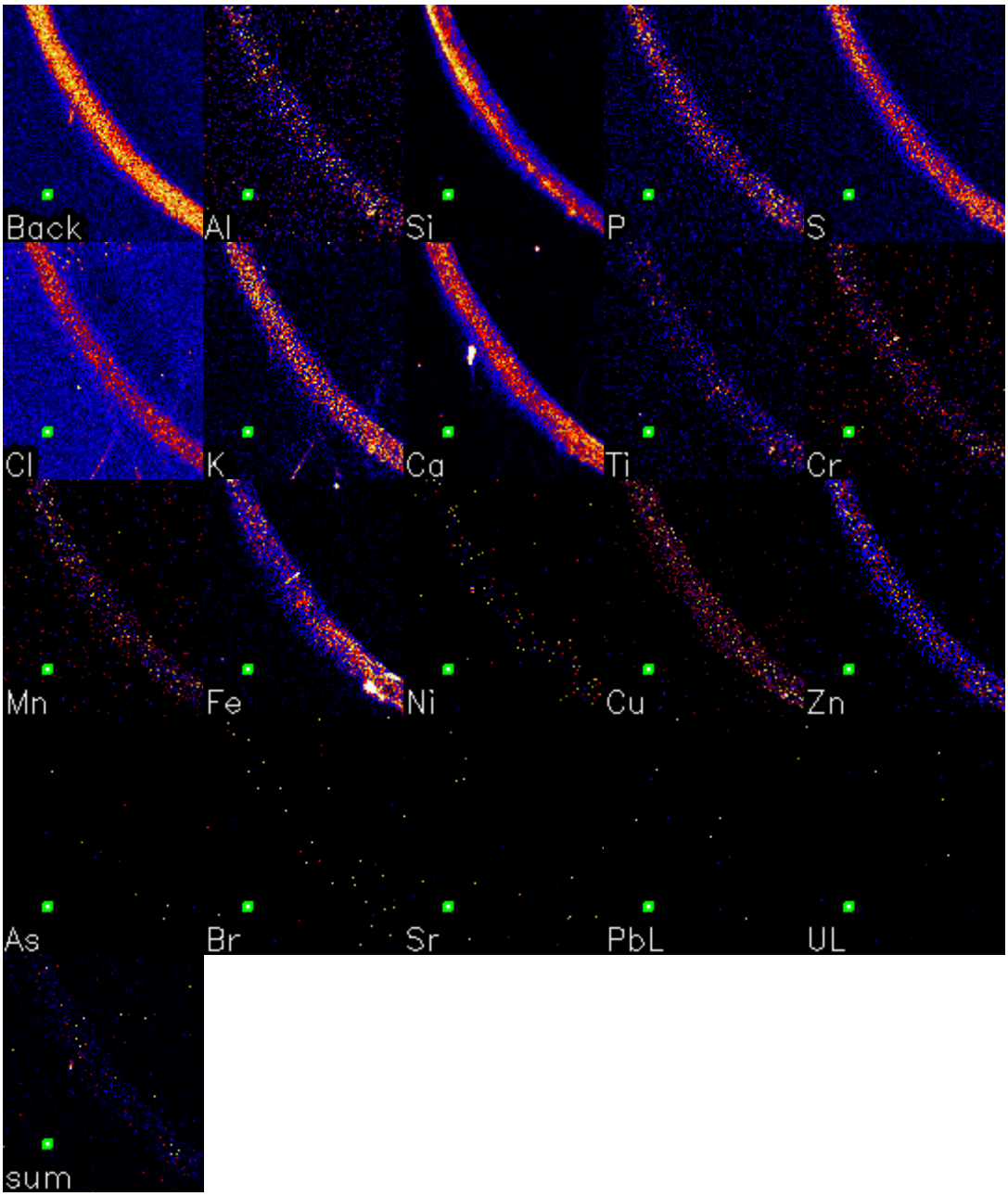
Relative Concentration Legend

Zero Maximum

Fig 3.5.14: Gauteng, Agnes Mine ABB5 R2 (5) (zamx_w295_12-regions-PIXE) Repeat of Fig 3.5.12 above . Ca, Cl, Fe, K, P, S, Si, and Ti, were localized in AMF roots with low concentration. Ti and Ca appear to be in low concentration on the elemental maps. Cl , P, S and Si appear to be wide spread across the root. Ca, Fe, Ti and K, appear to be accumulated in vesicles and Hyphae.

9. East Rand (ER)Metallurgical Plant (MP) A2 + A5 R1 (2)(zamx_w295_13-regions-PIXE).

File Name: zamx_w295_13.evt
Dynamic Matrix: zamx_w295_13q0.dam
Charge: 1650 µC
Scan: X= 493 µm, Y= 581 µm
Pixel: X size: 108, Y Size: 128



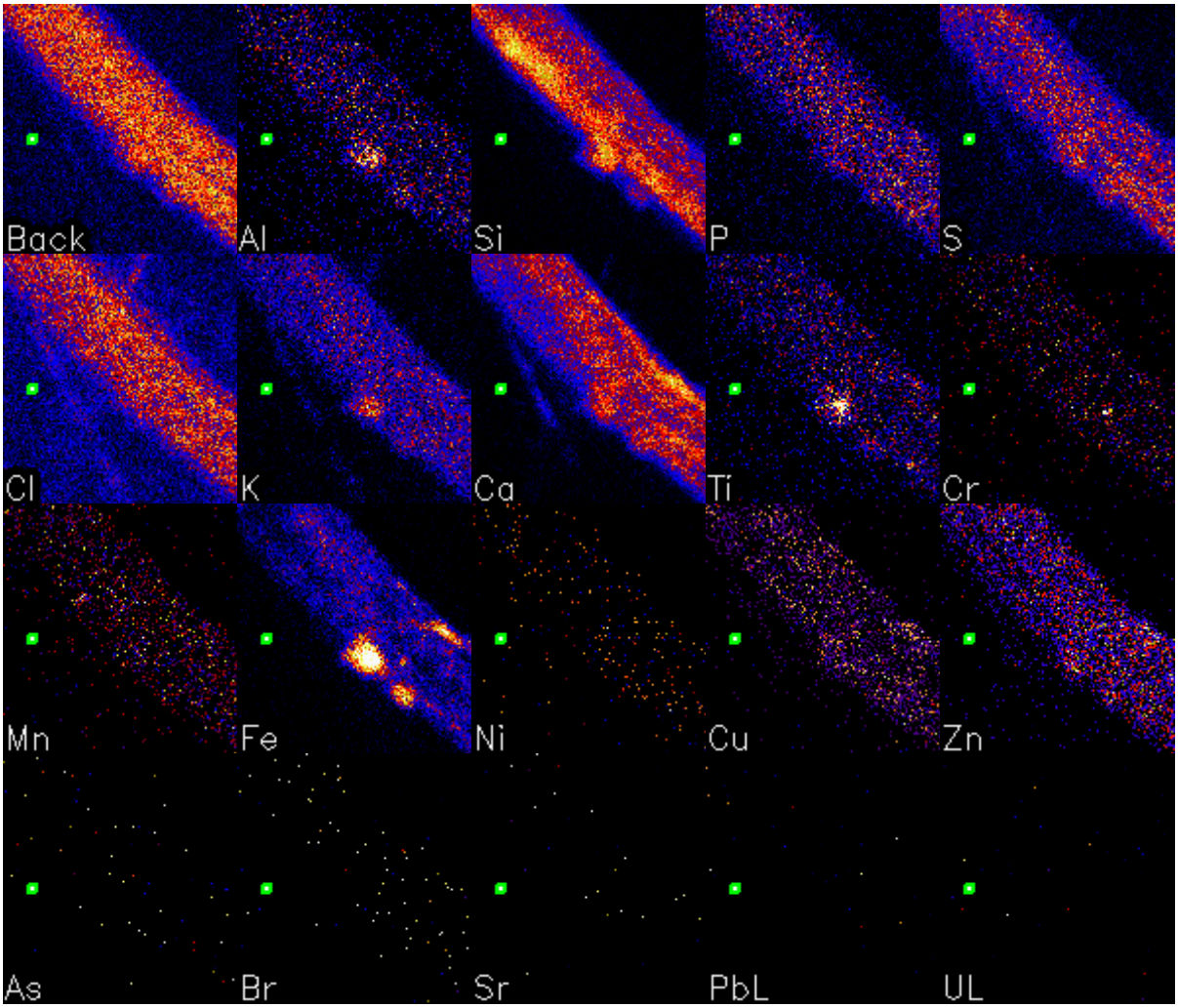
Relative Concentration Legend

Zero Maximum

Fig 3.5.15: East Rand (ER)Metallurgical Plant (MP) A2 + A5 R1 (2)(zamx_w295_13-regions-PIXE). Ca, Cl, Fe, Cu, Zn, K, Mn P, S, Ti and Si, were localized in AMF roots with low concentration. Ti and Mn appear to be in low concentration on the elemental maps. Ca, Cl, Cu, Zn, P, S, and Si appear to be wide spread across the root. Fe, Ti and K, appear to be accumulated in vesicles and Hyphae.

10. East Rand (ER)Metallurgical Plant (MP) A2 + A5 R1 (2)(zamx_w295_14-regions-PIXE).

File Name: zamx_w295_14.evt
Dynamic Matrix: zamx_w295_14q0.dam
Charge: 1217 µC
Scan: X= 158 µm, Y= 166 µm
Pixel: X size: 120, Y Size: 128



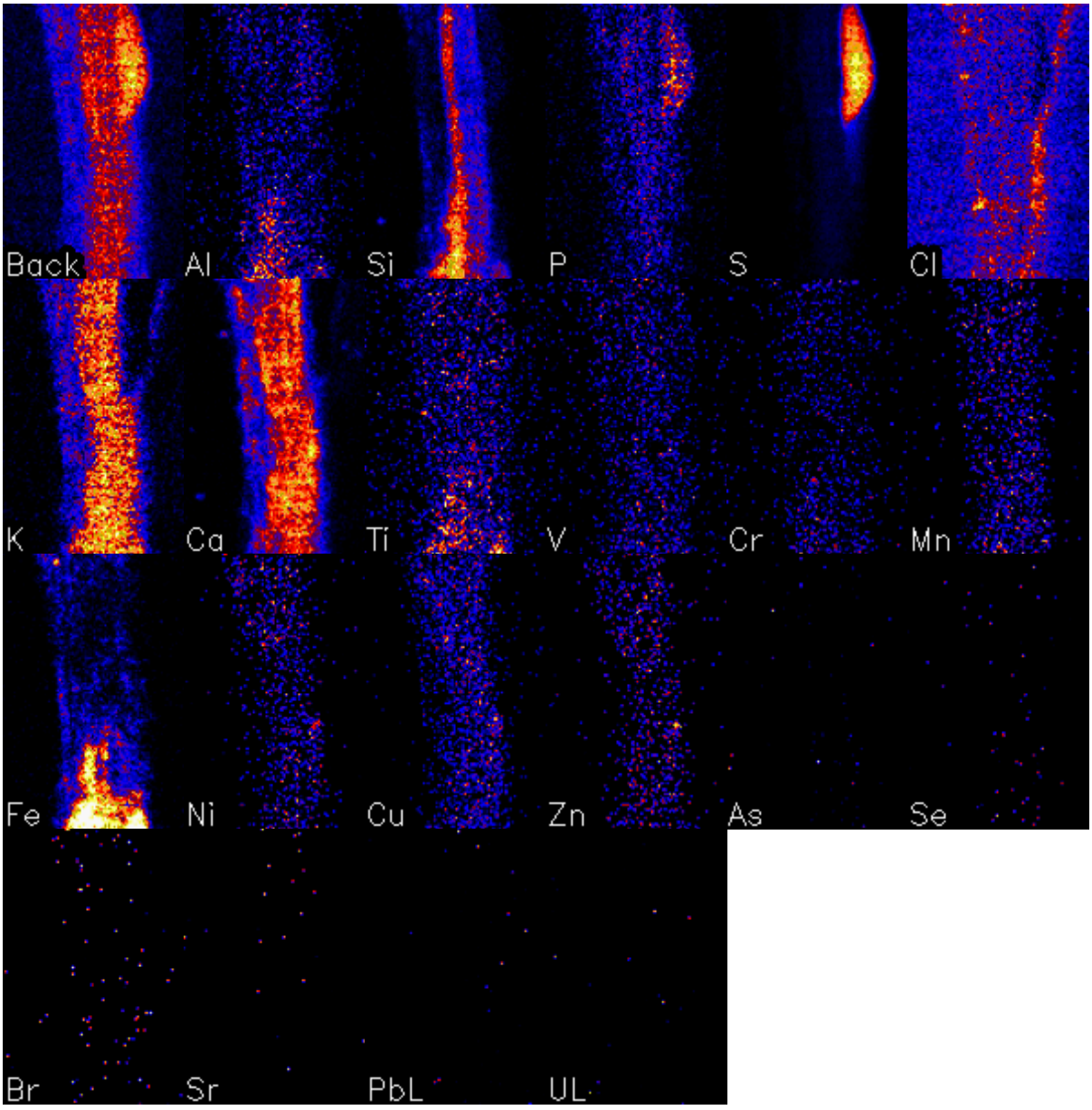
Relative Concentration Legend



Fig 3.5.16: East Rand (ER)Metallurgical Plant (MP) A2 + A5 R1 (2) (zamx_w295_14-regions-pixe)' Al, Ca, Cl, Fe, Mn, P, Cu, Zn, K, S, Cr, Ti and Si, were localized in AMF roots. Cl, S, Cu and Zn appear to be wide spread across the root. Al, Ca, Cr, Mn, Fe, Ti, Si and K, appear to be accumulated in vesicles and Hyphae.

11.North West (Rustenburg) Lonmin Platinum Mine (L) L1 R2 (5) (zamx_w295_15-regions-PIXE).

File Name: zamx_w295_15.evt
Dynamic Matrix: zamx_w295_15q0.dam
Charge: 731 µC
Scan: X= 222 µm, Y= 334 µm
Pixel: X size: 84, Y Size: 128



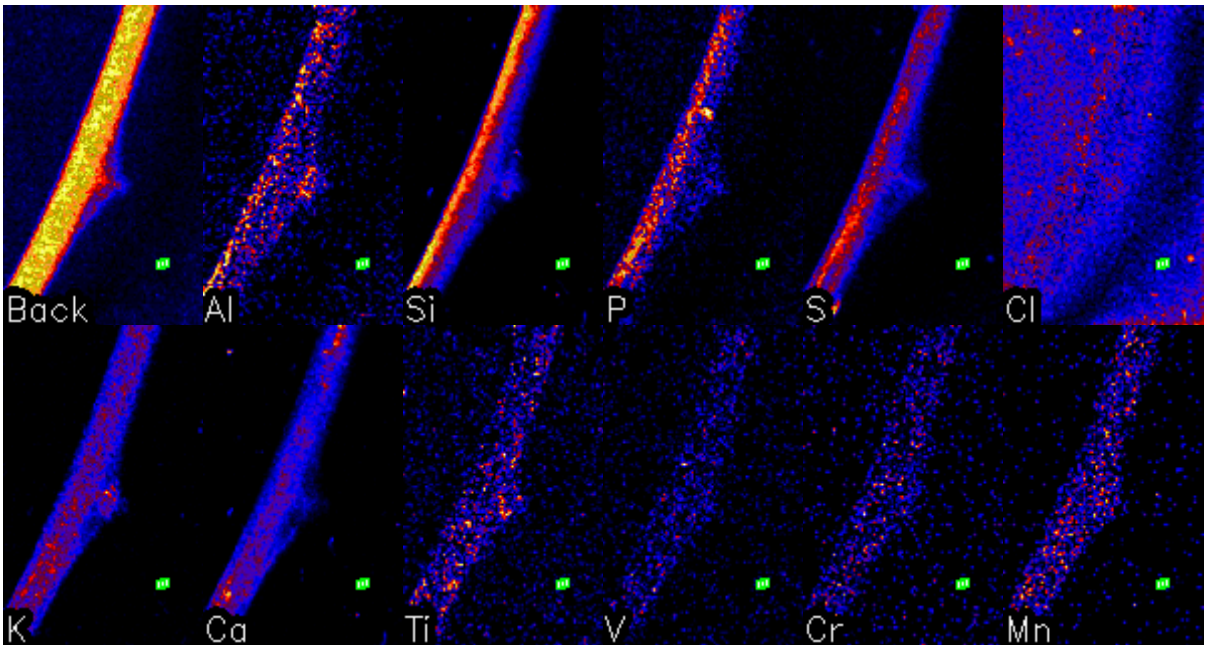
Relative Concentration Legend

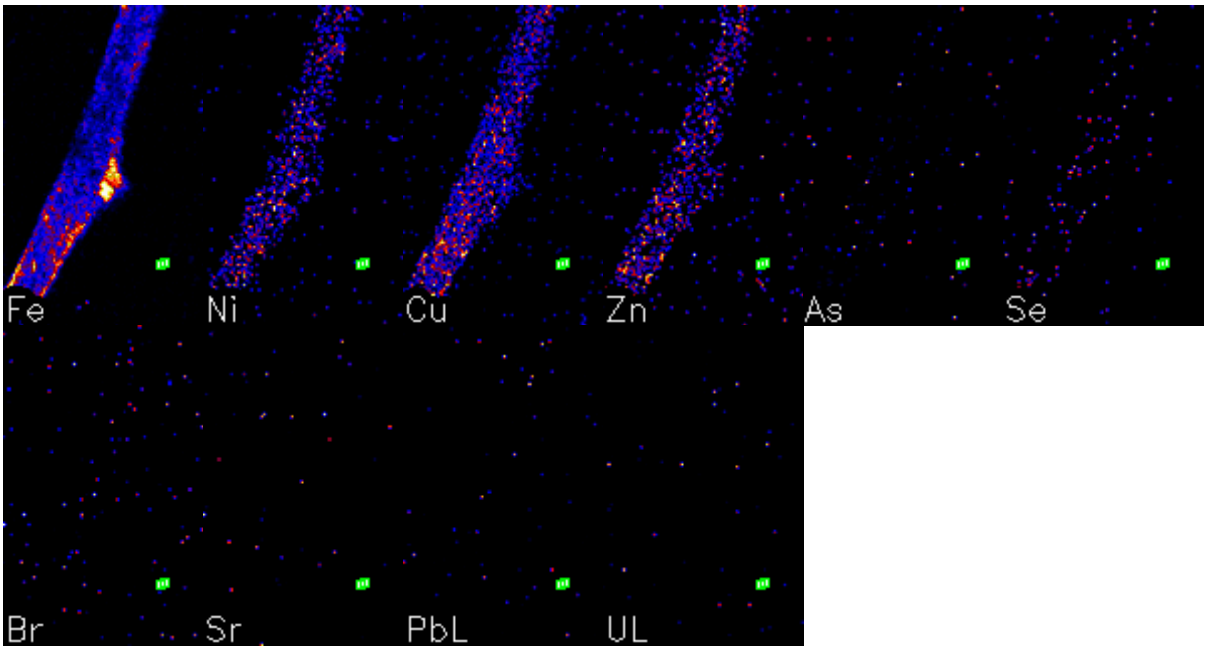
Zero  Maximum

Fig 3.5.17: North West (Rustenburg) Lonmin Platinum Mine (L) L1 R2 (5) (zamx_w295_15-regions-PIXE). Al, Ca, Cl, Fe, Ti, K and Si, were localized in AMF roots with low concentration. Fe, Ti and Al appear to be concentrated on one spot in the root elemental maps. Ca, Cl, K and Si appear to be wide spread across the root and localised in the centre of the root.

12.North West (Rustenburg) Lonmin Platinum Mine (L) L1 R2 (5) (zamx_w295_16-regions-PIXE).

File Name: zamx_w295_16.evt
Dynamic Matrix: zamx_w295_16q0.dam
Charge: 2838 µC
Scan: X= 1077 µm, Y= 1168 µm
Pixel: X size: 80, Y Size: 128





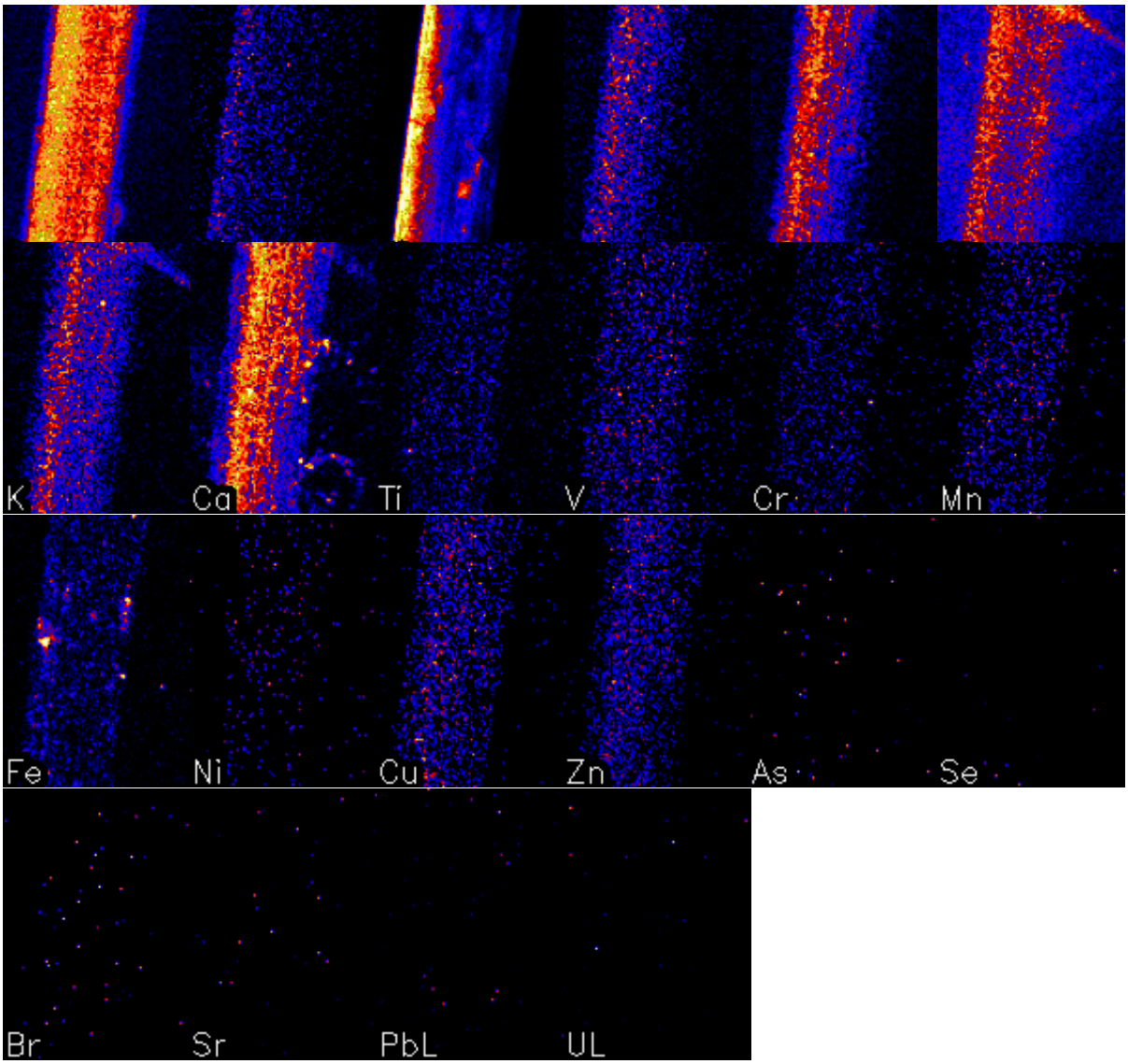
Relative Concentration Legend

Zero  Maximum

Fig 3.5.18: North West (Rustenburg) Lonmin Platinum Mine (L) L1 R2 (5) (zamx_w295_16-regions-PIXE). Al, Ca, Cu, Cl, Fe, Mn, Ni, Zn, K, P, S, Si and Ti, were localized in AMF roots with low concentration. Al, Cu, Cl, Mn, Ni, Zn, K, P, S and Si appear to be wide spread across the root and localised in the centre of the root. Fe, Ca and Ti, appear to be accumulated in vesicles and Hyphae.

13.East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1 (1) (zamx_w295_17-regions-PIXE).

File Name: zamx_w295_17.evt
Dynamic Matrix: zamx_w295_17q0.dam
Charge: 1381 µC
Scan: X= 356 µm, Y= 500 µm
Pixel: X size: 88, Y Size: 128



Relative Concentration Legend

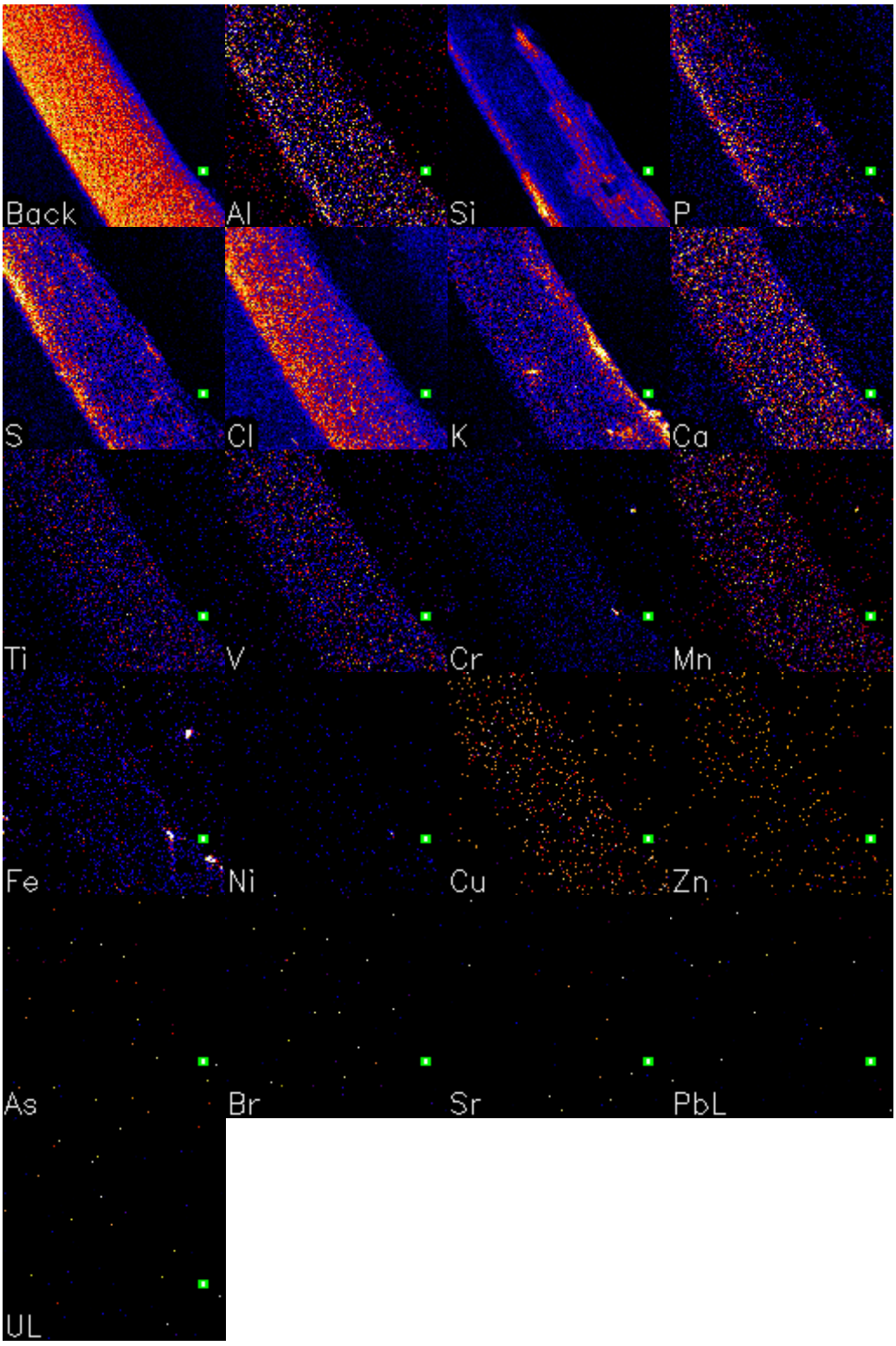
Zero  Maximum

Fig 3.5.19: East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1 (1) (zamx_w295_17-regions-PIXE). Ca, Cl, Cu, Fe, S, K and Si, were localized in AMF roots. Ca, Cl, S, K and Si, appear to be wide spread across the root and localized in the centre of the root. While Fe and Cu, appear to be accumulated in vesicles and Hyphae.

14.Ctr + Nu R2 (4) (zamx_w295_18-regions-PIXE).

File Name: zamx_w295_18.evt
Dynamic Matrix: zamx_w295_18q0.dam
Charge: 1415 µC
Scan: X= 584 µm, Y= 584 µm

Pixel: X size: 128, Y Size: 128



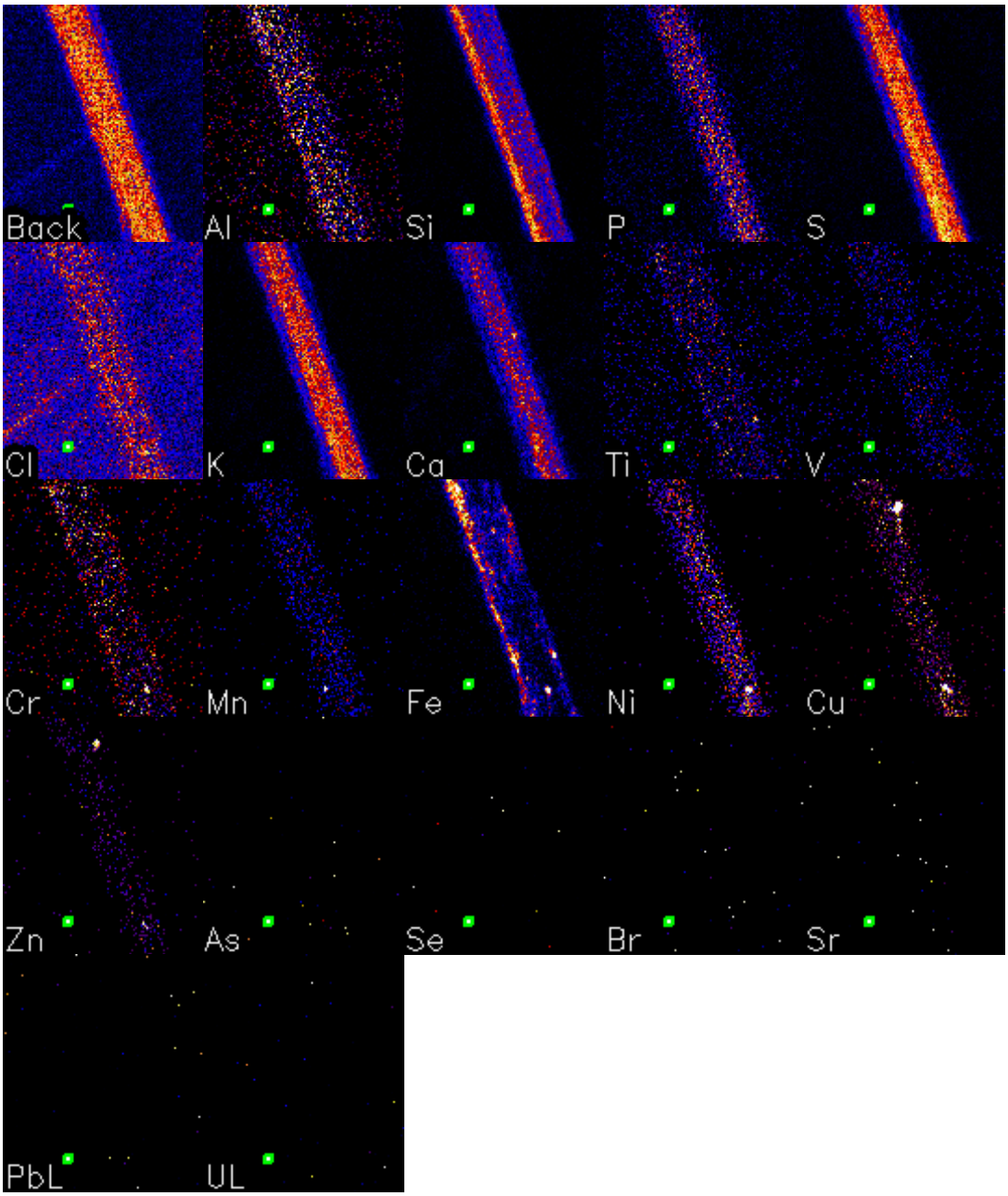
Relative Concentration Legend

Zero  Maximum

Fig 3.5.20: Ctr + Nu R2 (4) (zamx_w295_18-regions-PIXE). Al, Ca, Cl, Cr, Fe, P, S, K and Si, were localized in AMF roots with low concentration. Cl, Cr, Fe, S, K and Si, appear to be wide spread across the root and localized in the centre of the root. While Fe, Cr, K, appear to be accumulated in some parts of the root.

15. Gauteng, Agnes Mine ABB5 R2 (5) Reg 0 -1 (zamx_w295_19-regions-PIXE).

File Name: zamx_w295_19.evt
Dynamic Matrix: zamx_w295_19q0.dam
Charge: 1509 µC
Scan: X= 287 µm, Y= 333 µm
Pixel: X size: 108, Y Size: 128



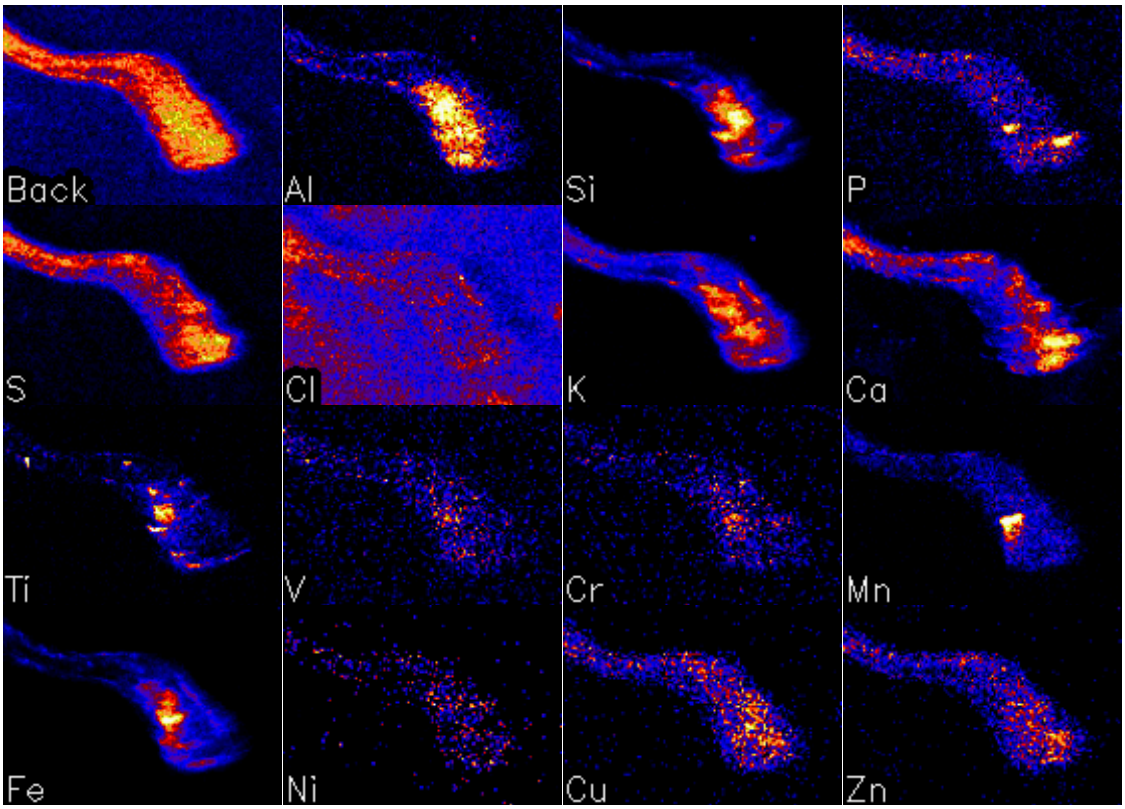
Relative Concentration Legend

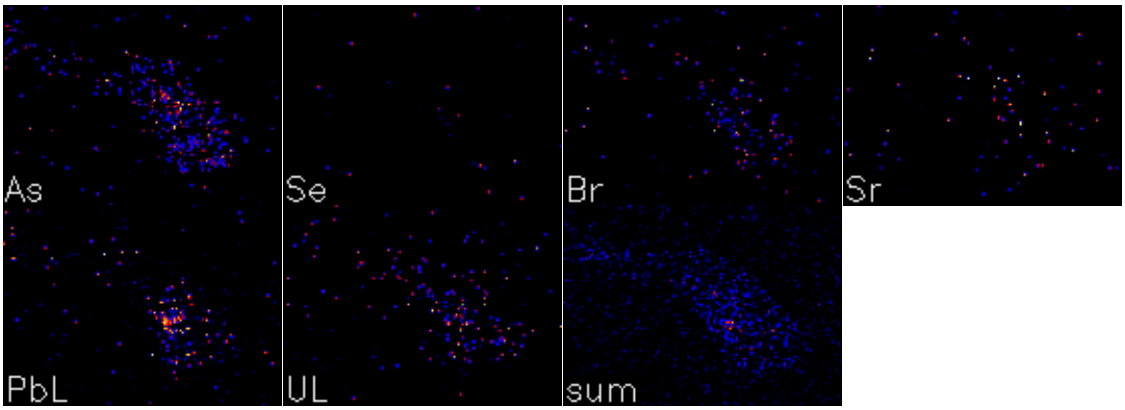


Fig 3.5.21: Gauteng, Agnes Mine ABB5 R2 (5) Reg 0 -1 (zamx_w295_19-regions-PIXE). Al, Ca, Cl, Cr, Cu, Ni, P, Zn, and Fe, with exception of Si, S, K, were localized in AMF roots with low concentration. Al, Ca, Cl, Cr, P, S K and Si, appear to be wide spread across the root and localized in the centre of the root. While Fe, Cu, Ni and Zn appear to be accumulated in vesicles and Hyphae.

16. North West (Vaal Reefs) Au +Ur) S11 R2 (2) (zamx_w295_20-regions-PIXE).

File Name: zamx_w295_20.evt
Dynamic Matrix: zamx_w295_20q0.dam
Charge: 3066 µC
Scan: X= 584 µm, Y= 429µm
Pixel: X size: 128, Y Size: 92





Relative Concentration Legend

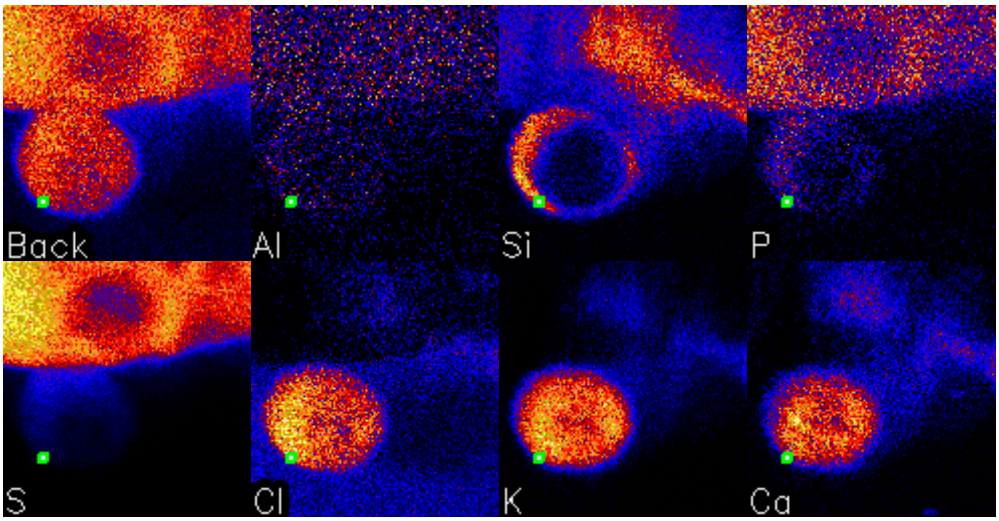
Zero  Maximum

Fig 3.5.22: North West (Vaal Reefs) Au +Ur) S11 R2 (2) (zamx_w295_20-regions-PIXE).

Al, Ca, Cl, Cr, Cu, Mn, P, Fe, K, S, Si, Zn, V, T, PbL and Ul were localized in AMF roots with low concentration. S, and Ul appear to be wide spread across the root and localized in the centre of the root. While Al, Ca, Cl, Cr, Cu, Mn, P, Fe, K, S, Si, Zn, V, T, PbL and Ul appear to be accumulated in vesicles and Hyphae.

17. Gauteng, Agnes Mine ABB5 R1 (8) (zamx_w295_21-regions-PIXE) root cross-section..

File Name: zamx_w295_21.evt
Dynamic Matrix: zamx_w295_21q0.dam
Charge: 1886 µC
Scan: X= 329µm, Y= 334µm
Pixel: X size: 124, Y Size: 128



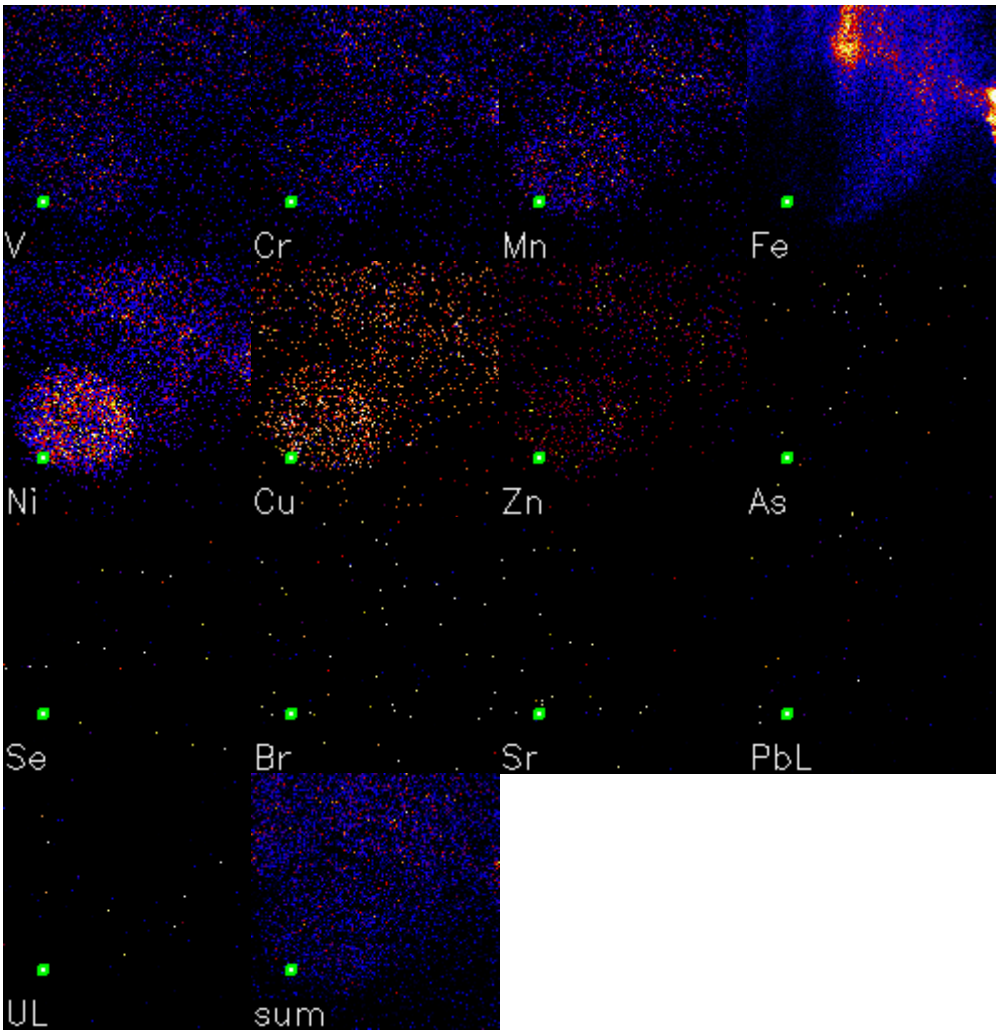
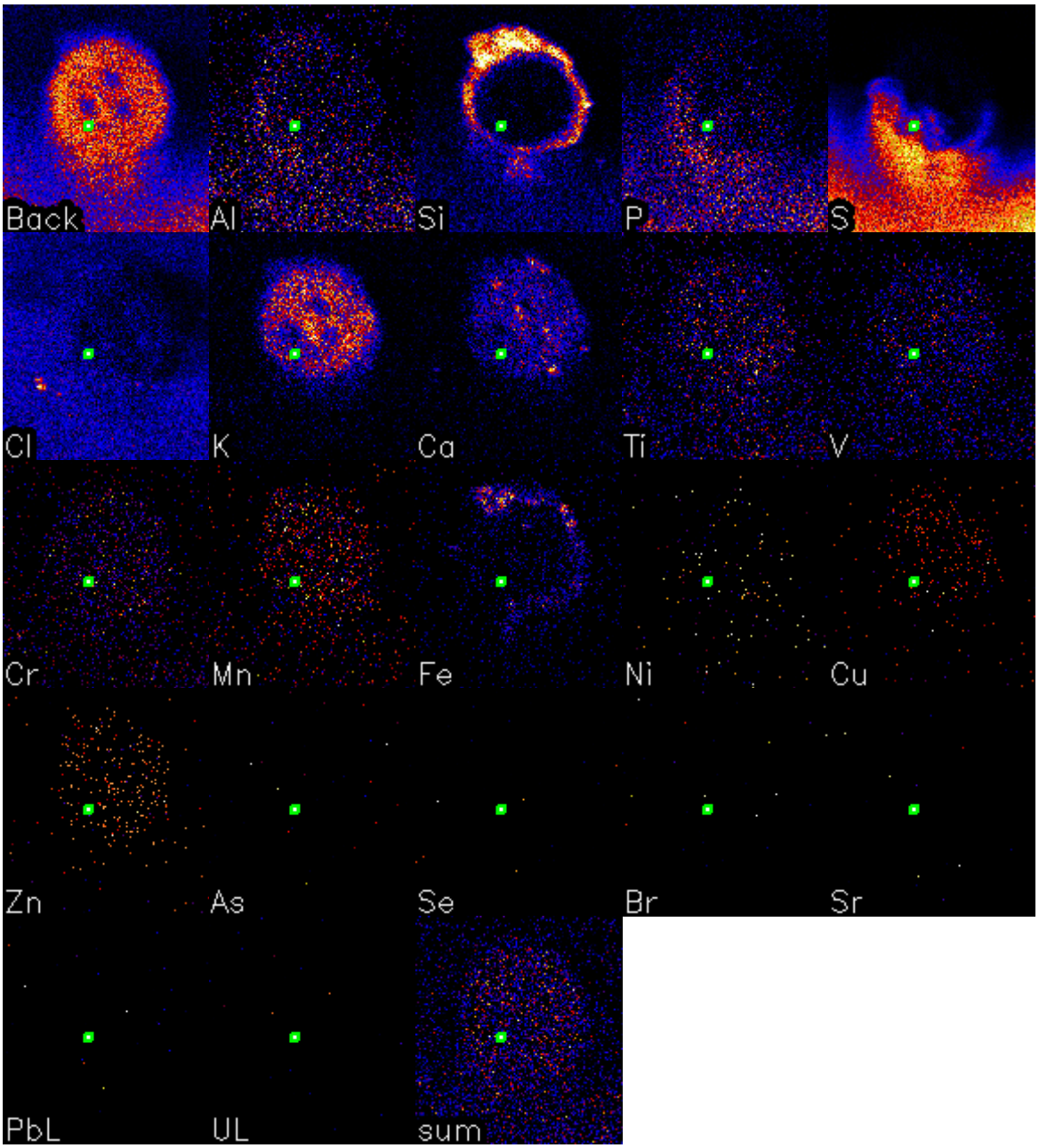


Fig 3.5.23: Gauteng, Agnes Mine ABB5 R1 (8) (zamx_w295_21-regions-PIXE) root cross-section. Ca, Cl, K, and Si, except Ni, Cu, and Zn were localized in AMF roots with high concentration.

18. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) (zamx_w295_22-regions-PIXE) root cross-section

File Name: zamx_w290_22.evt
Dynamic Matrix: zamx_w295_22q0.dam
Charge: 1159 µC
Scan: X= 461 µm, Y= 500 µm
Pixel: X size: 116, Y Size: 128



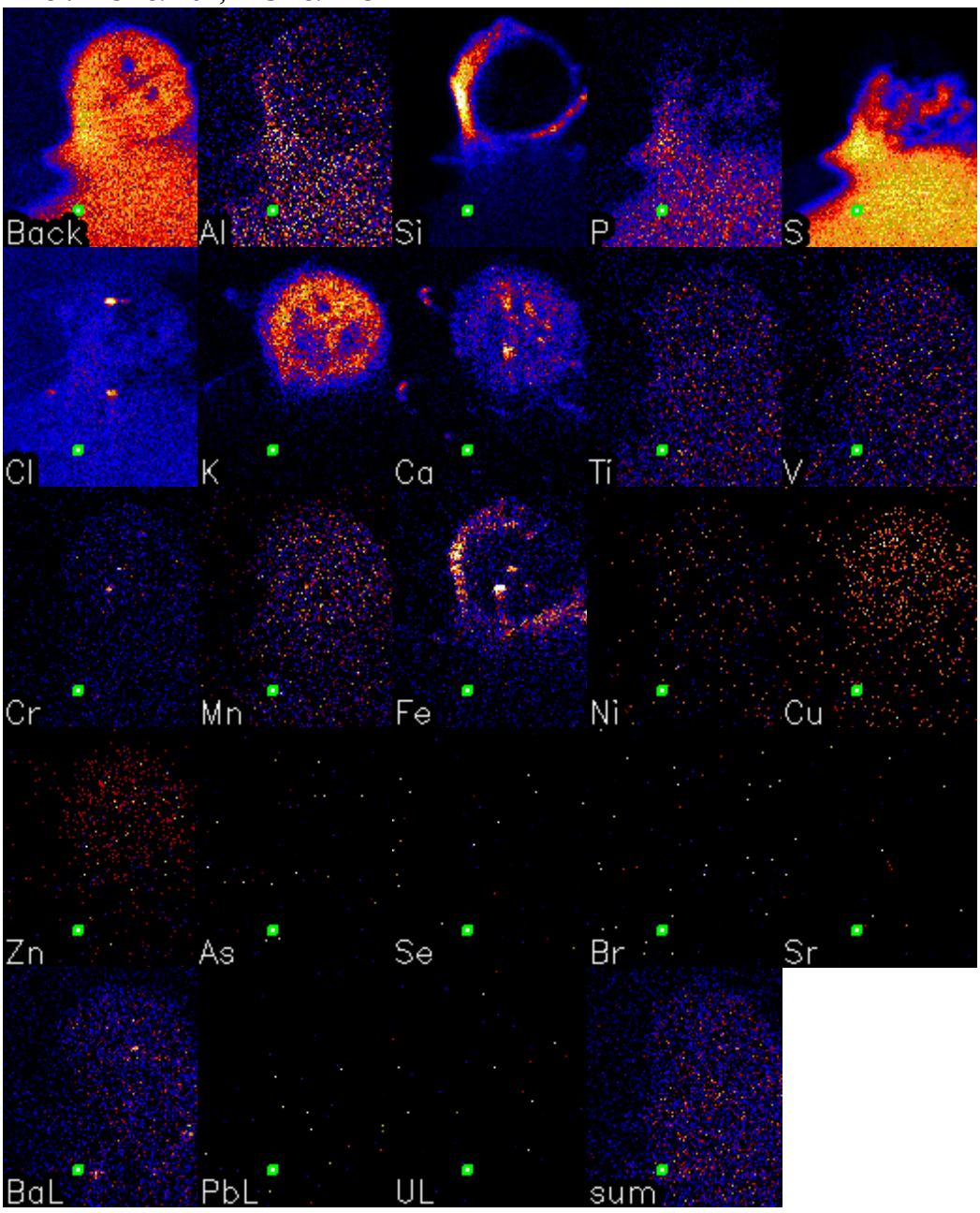
Relative Concentration Legend

Zero — Maximum

Fig 3.5.24: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) (zamx_w295_22-regions-PIXE) root cross-section. Ca, Fe, K, and Si, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, except K which is spread across the root cross-section.

19.East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) (zamx_w295_23-regions-PIXE) root cross-section.

File Name: zamx_w290_23.evt
Dynamic Matrix: zamx_w295_23q0.dam
Charge: 2212 µC
Scan: X= 411 µm, Y= 501 µm
Pixel: X size: 104, Y Size: 128



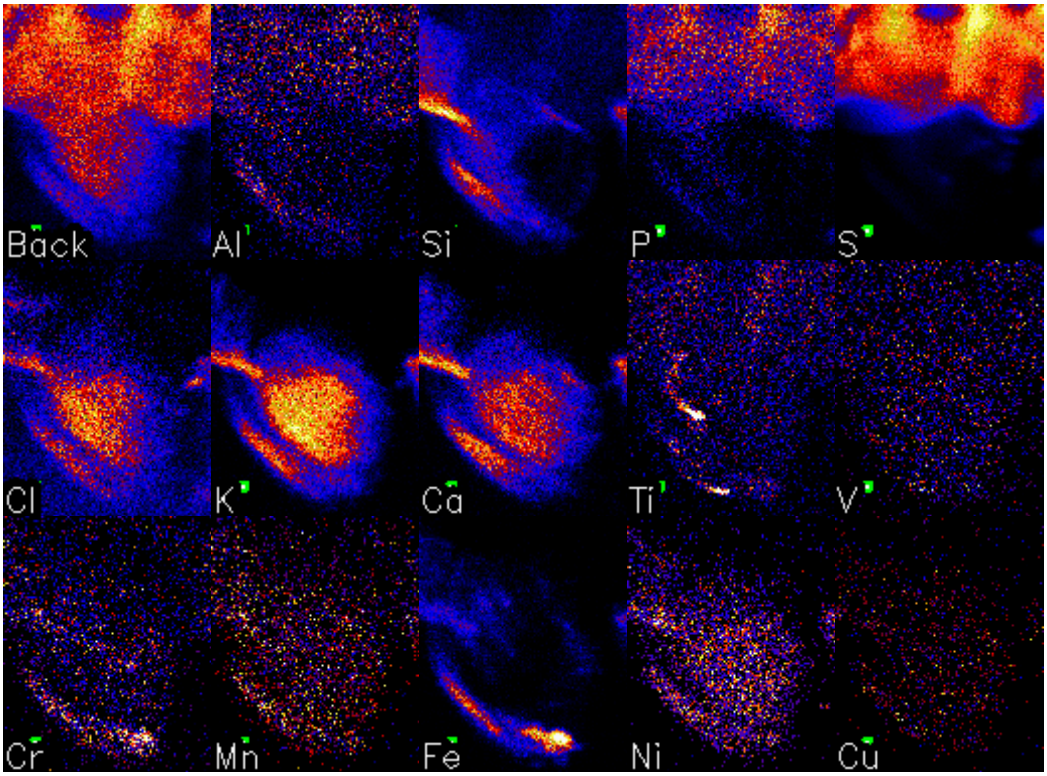
Relative Concentration Legend

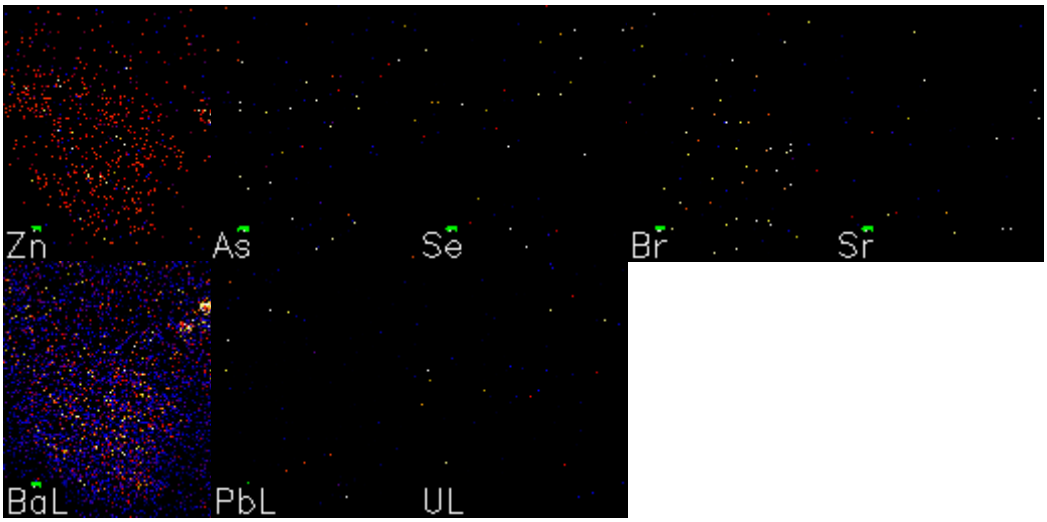


Fig 3.5.25: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) (zamx_w295_23-regions-PIXE) root cross-section. Ca, Cl, Fe, K, Si and Cr, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, except K which is spread across the root cross-section.

20. Gauteng, Agnes Mine ABB5 R1 (5) B (zamx_w295_24-regions-PIXE) root cross-section.

File Name: zamx_w290_24.evt
Dynamic Matrix: zamx_w295_24q0.dam
Charge: 1173 µC
Scan: X= 348 µm, Y= 417 µm
Pixel: X size: 104, Y Size: 128





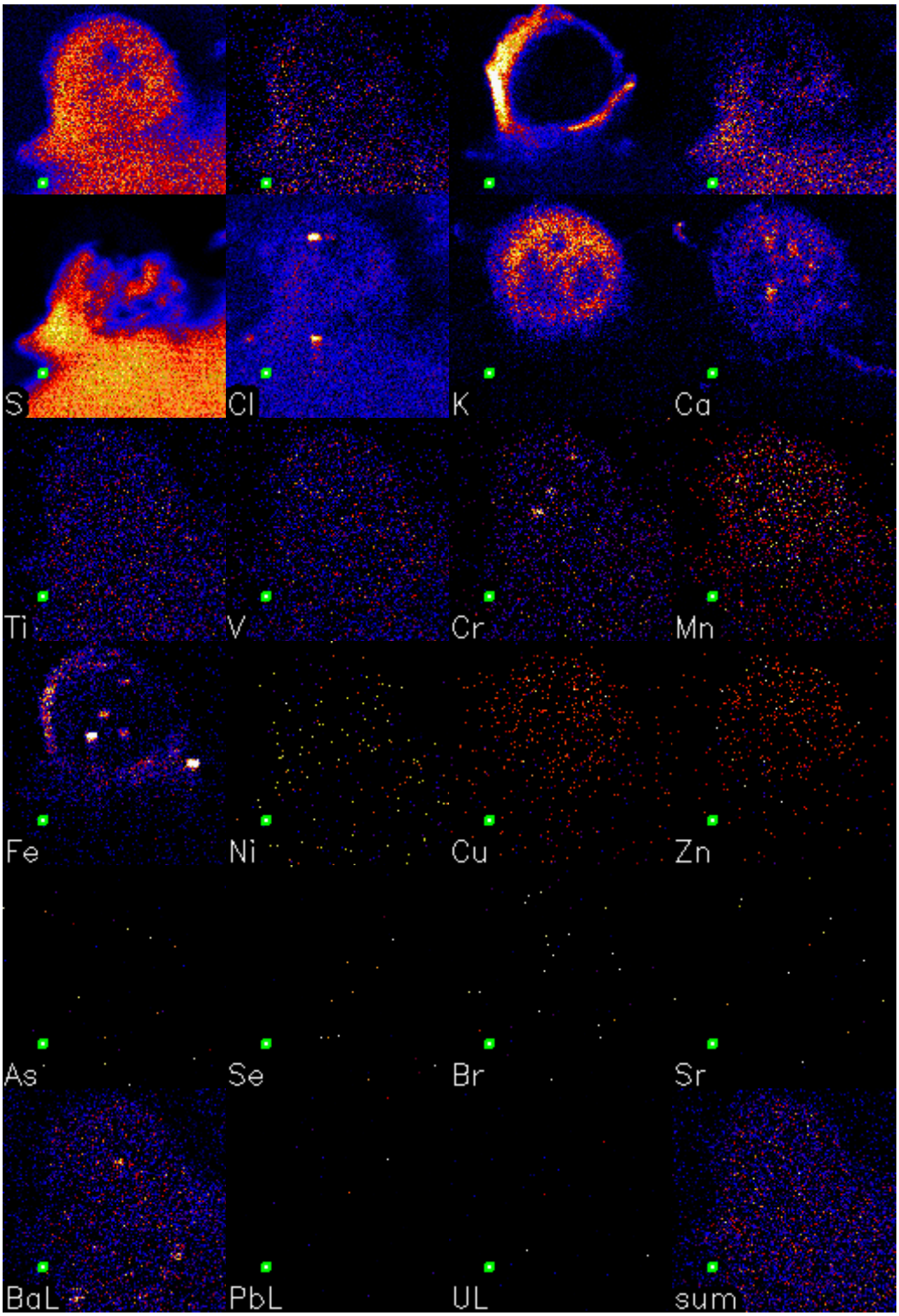
Relative Concentration Legend



Fig 3.5.26: Gauteng, Agnes Mine ABB5 R1 (5) B (zamx_w295_24-regions-PIXE) root cross-section. Ca, Cl, Fe, K, Si, BaL, Ti and Cr, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, except K which is spread across the root cross-section. Surprisingly, the average concentration of BaL is below the detection limit but it appears to be in the vesicles in the elementary Maps.

21. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) B (zamx_w295_25-regions-PIXE) root cross-section.

File Name: zamx_w295_25.evt
Dynamic Matrix: zamx_w295_25q0.dam
Charge: 1347 µC
Scan: X= 417 µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128



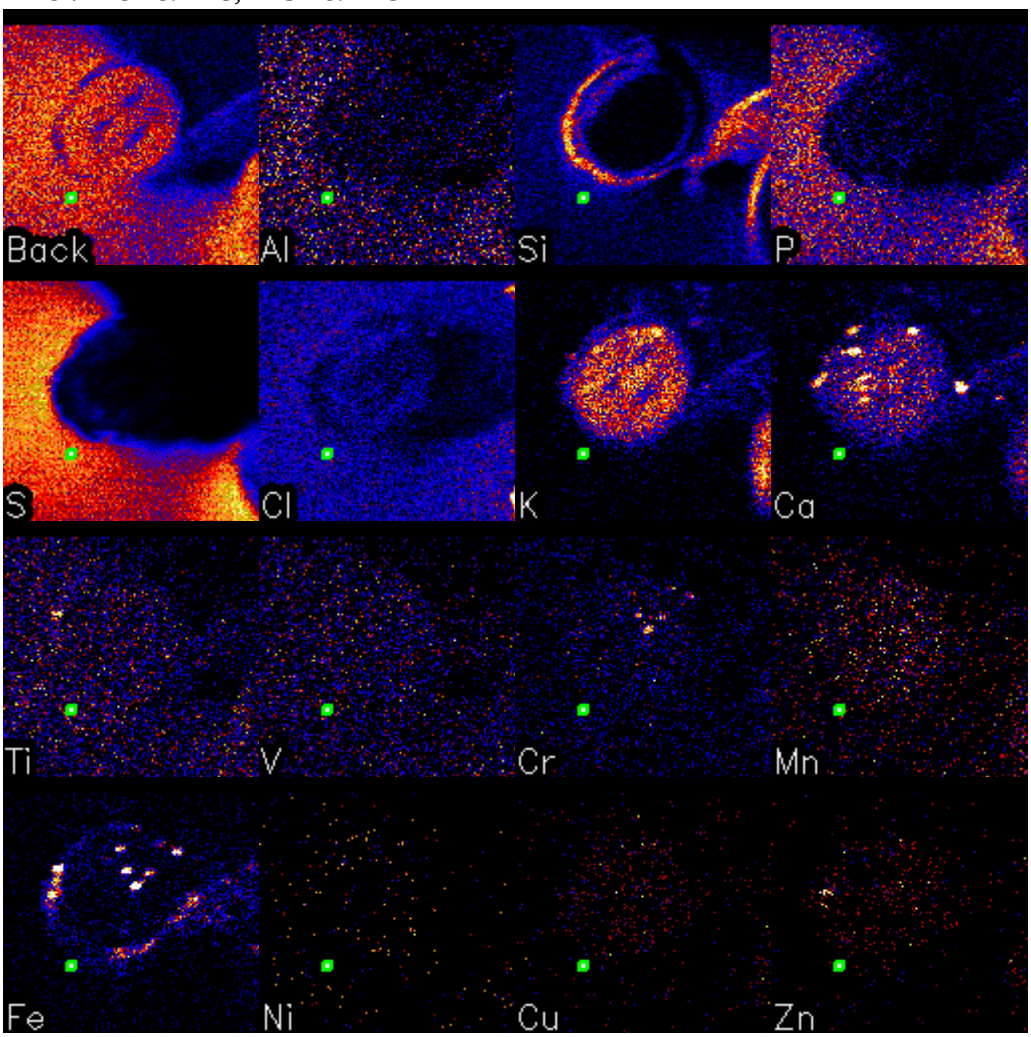
Relative Concentration Legend

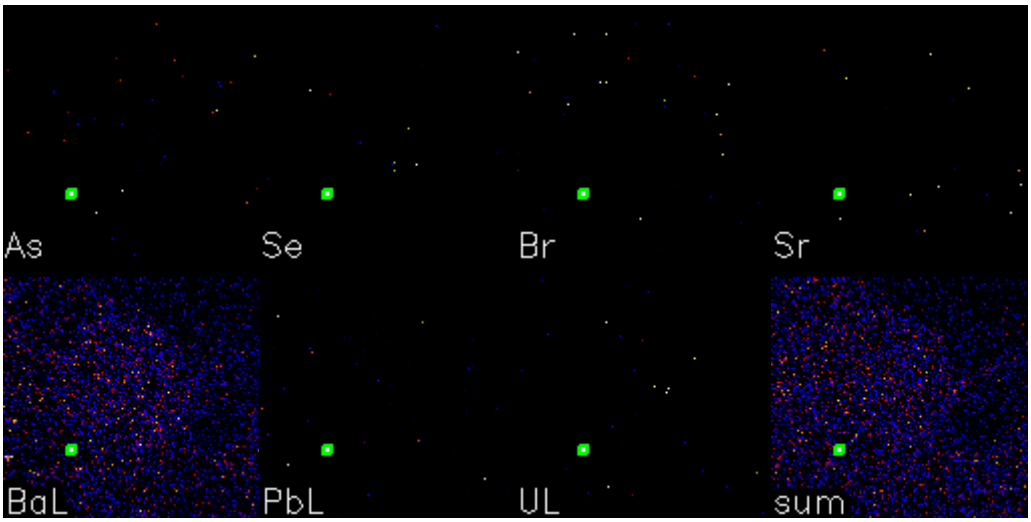
Zero  Maximum

Fig 3.5.27: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) B (zamx_w295_25-regions-PIXE) root cross-section. Ca, Cl, BaL Cr, Fe, K, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, except K which is spread across the root cross-section. Same thing has been noticed about BaL as stated in **Fig 3.5.27** above, the average concentration of BaL is below the detection limit but it appears to be in the vesicles in the elementary Maps.

22. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) C (zamx_w295_26-regions-PIXE) root cross-section.

File Name: zamx_w295_26.evt
Dynamic Matrix: zamx_w295_26q0.dam
Charge: 1112 µC
Scan: X= 500 µm, Y= 470 µm
Pixel: X size: 128, Y Size: 128





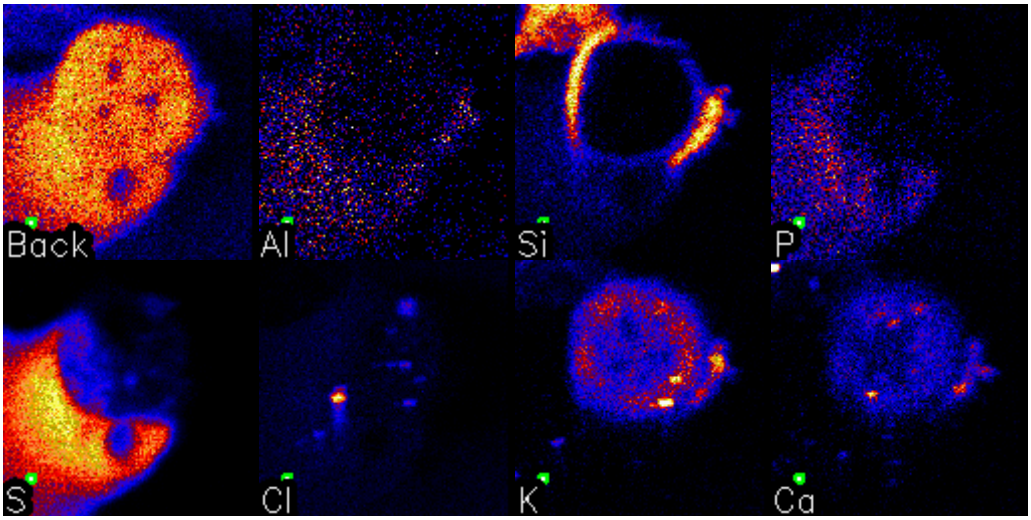
Relative Concentration Legend

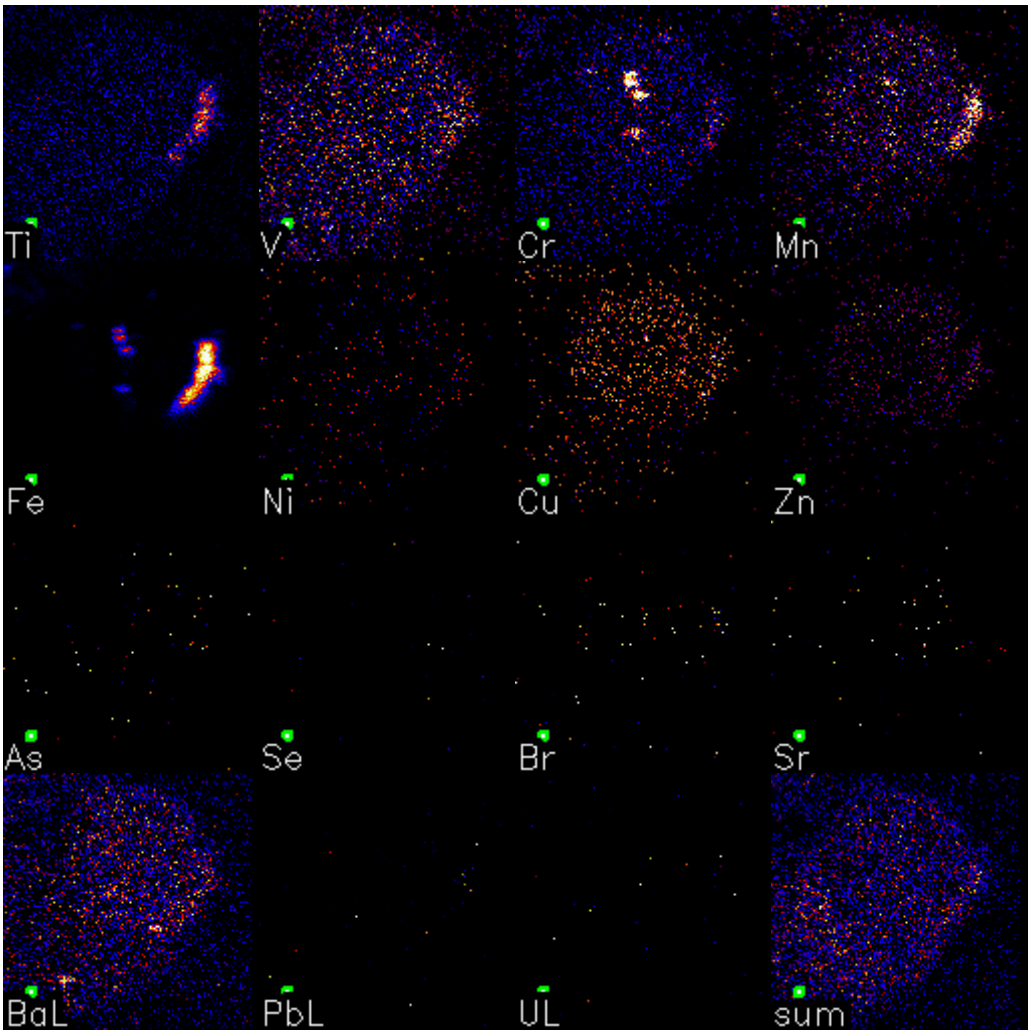
Zero  Maximum

Fig 3.5.28: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) C (zamx_w295_26-regions-PIXE) root cross-section. Ca, Cr, Fe, K, Zn Ti and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, except K which is spread across the root cross-section.

23. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) D (zamx_w295_27-regions-PIXE) root cross-section.

File Name: zamx_w295_27.evt
Dynamic Matrix: zamx_w295_27q0.dam
Charge: 1977 µC
Scan: X= 407 µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128





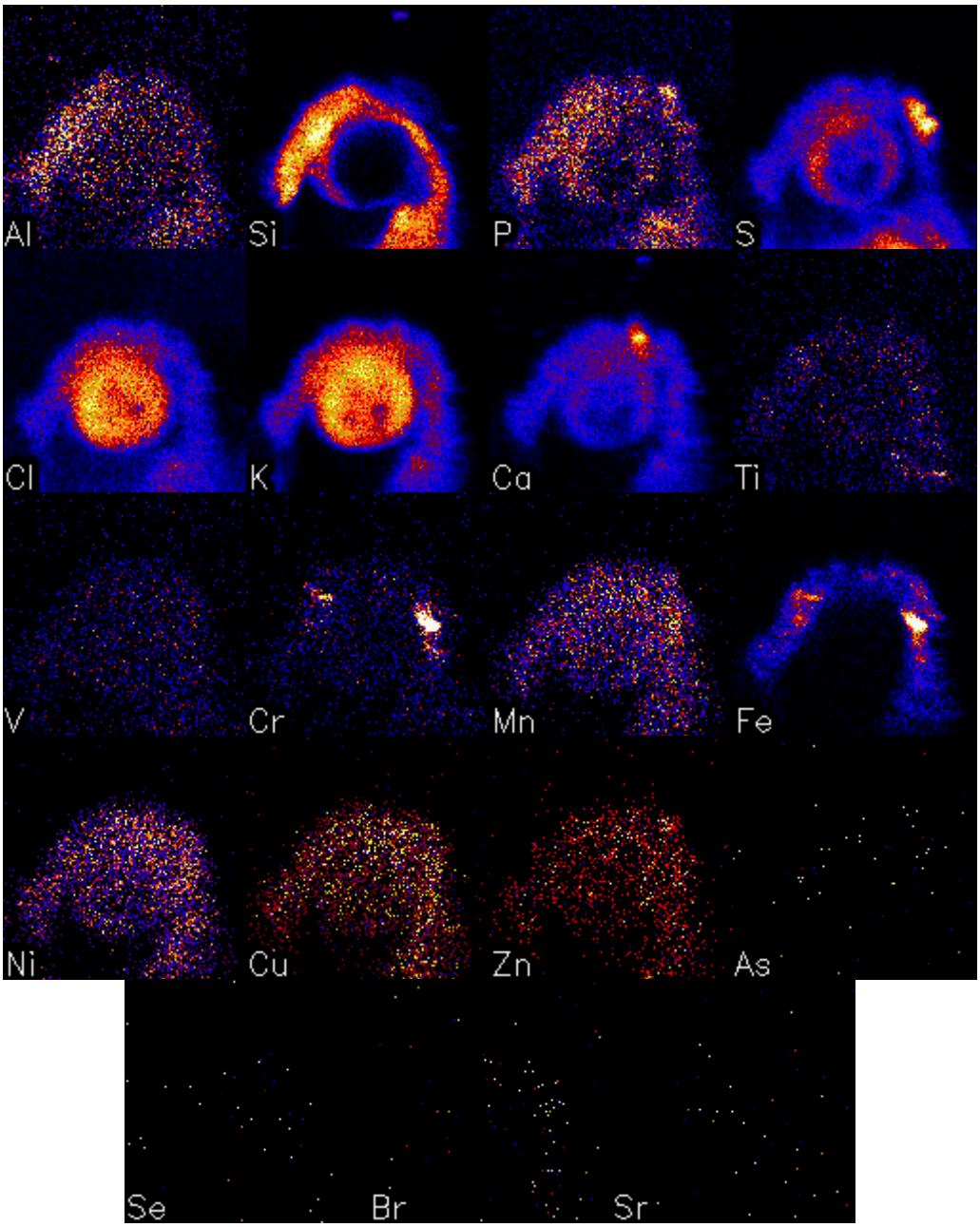
Relative Concentration Legend

Zero Maximum

Fig 3.5.29: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) D (zamx_w295_27-regions-PIXE) root cross-section. Ca, Cl, BaL Cr, Fe, K, Mn Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. Same thing has been noticed about BaL as stated in **Fig 3.5.27 &Fig 3.5.28** above, the average concentration of BaL is below the detection limit but it appears to be in the vesicles in the elementary Maps.

24.L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) (zamx_w295_28-regions-PIXE) root cross-section.

File Name: zamx_w295_28.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1852 µC
Scan: X= 334 µm, Y= 334 µm
Pixel: X size: 128, Y Size: 128



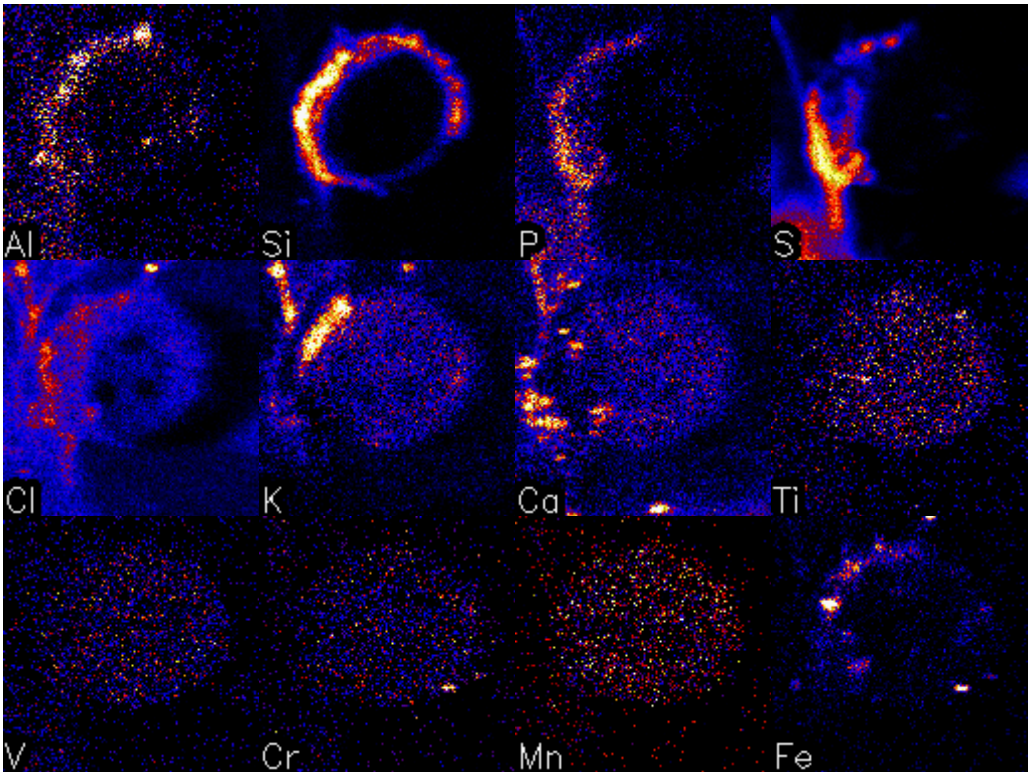
Relative Concentration Legend

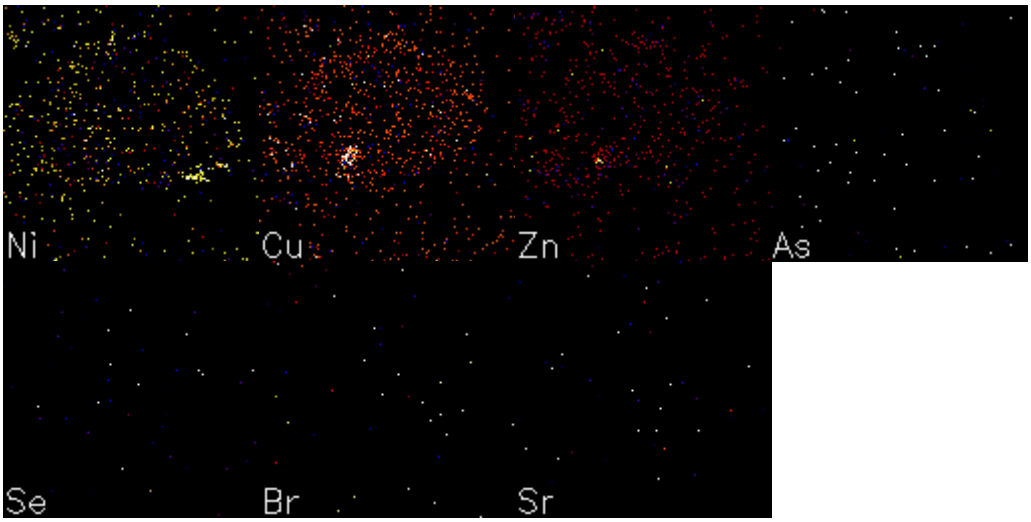
Zero **Maximum**

Fig 3.5.30: L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) (zamx_w295_28-regions-PIXE) root cross-section. Ca, Cr, Fe, S and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae, While Cl, K, Mn, Cu, Zn, Ni and P appear to be spread across the root cross-section. *Except for K, and Cl,* a*ccumulation of elements has been observed largely in the peal; this might indicate that most AMF structures are located in the peal of the plant.*

25.*L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM14 (zamx_w295_29-regions-PIXE).*

File Name: zamx_w295_29.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2055 µC
Scan: X= 417 µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128





Relative Concentration Legend

Zero Maximum

Fig 3.5.31: ***L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM14 (zamx_w295_29-regions-PIXE).*** Al, Cl, Ca, Cr, Cu, Fe, K, Mn, Ni, P, S, Zn, Ti and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. *It is also true for this sample, Accumulation of elements has been observed largely in the epidermal outer cortical layer (peal or bark) of the root crossections. This might indicate that most AMF structures are located in the epidermal layer of the plant.*

26.*L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM15 (zamx_w295_32-regions-PIXE).*

File Name: zamx_w295_32.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1185 µC
Scan: X= 351 µm, Y= 417 µm
Pixel: X size: 124, Y Size: 128

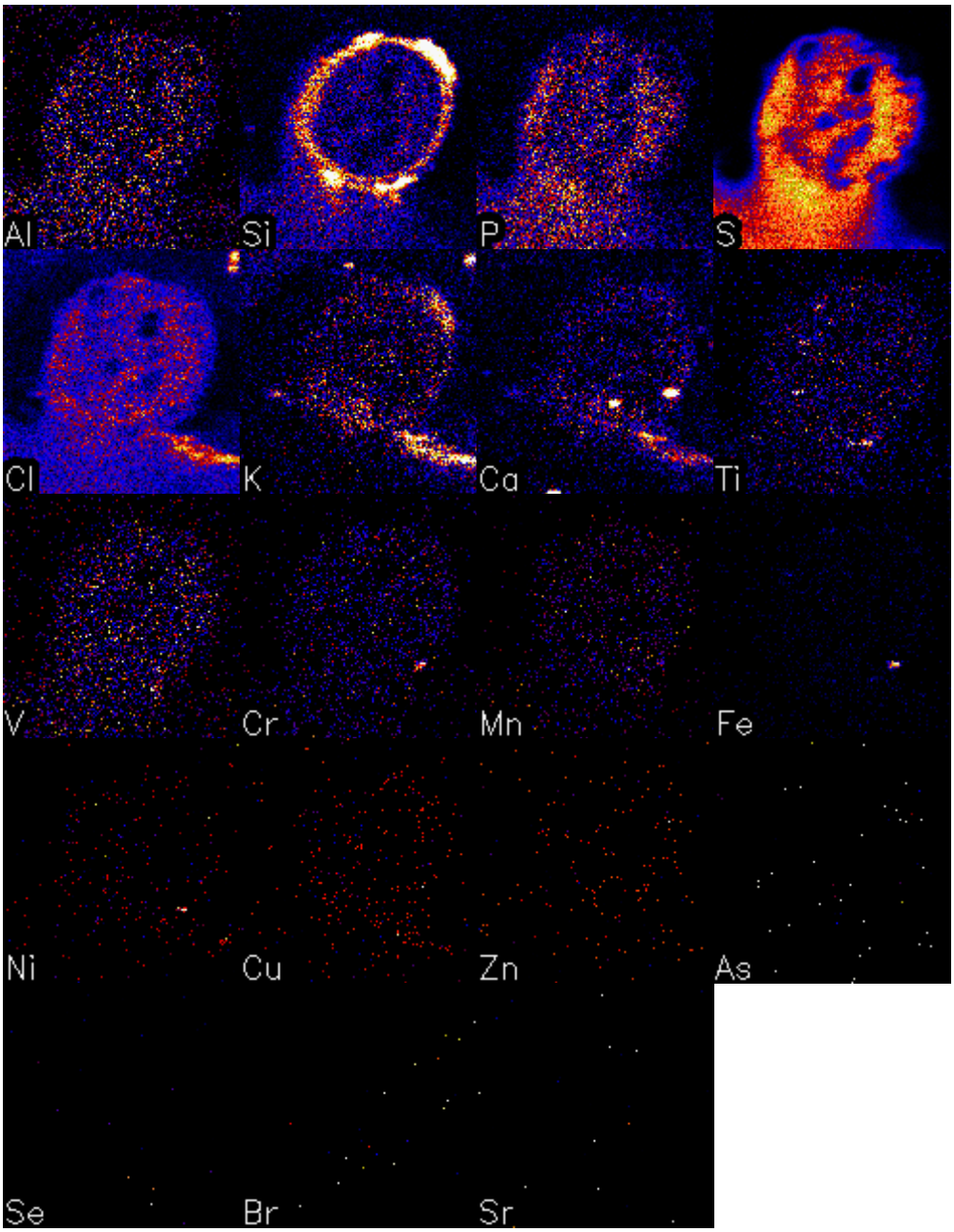
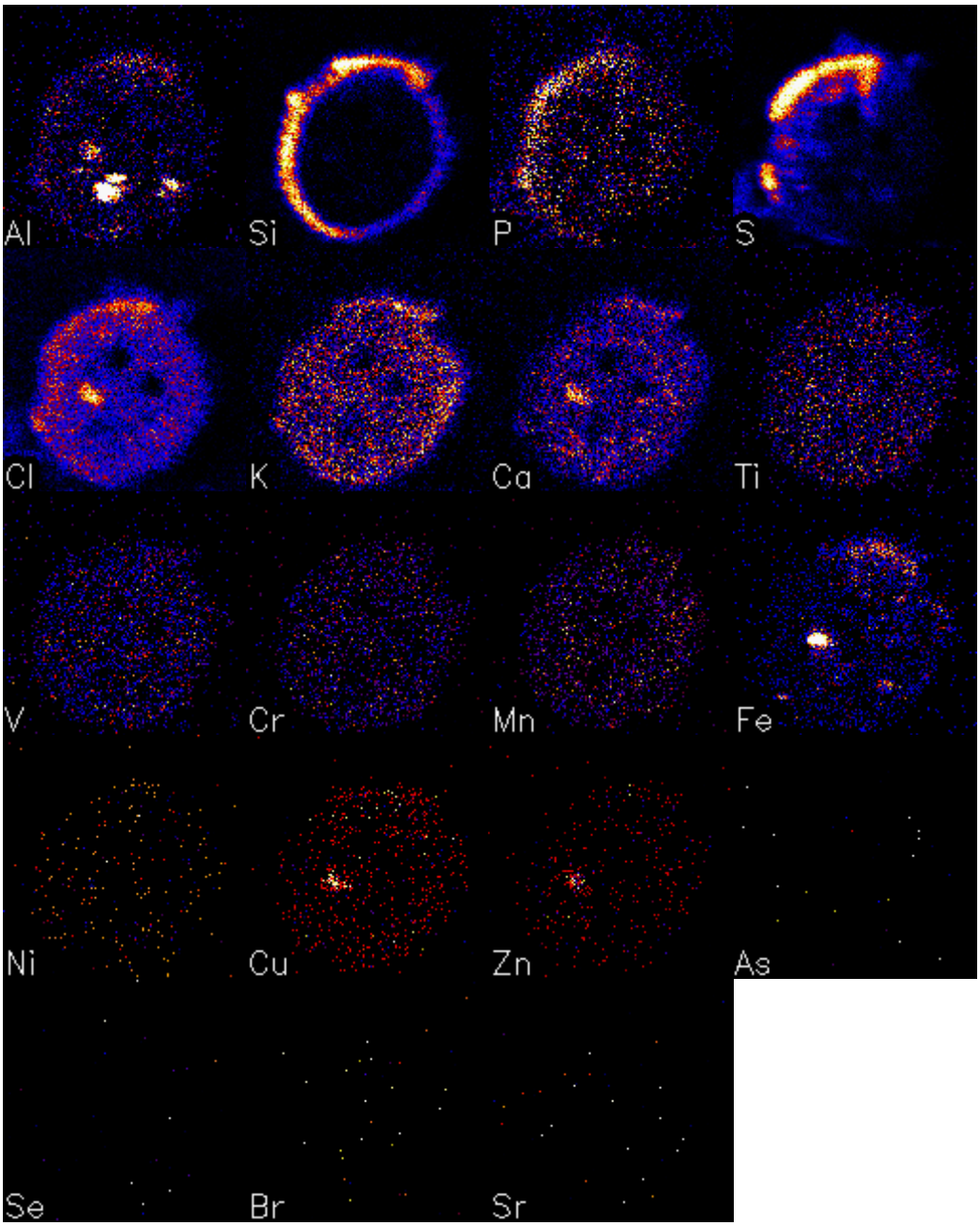


Fig 3.5.32: L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM15 (zamx_w295_32-regions-PIXE). Ca, Cr, Fe, Ti, K and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, S and P appear to be spread across the root cross-section. The average concentration of Ti is below the detection limit but it appears in the vesicles in the elementary Maps. *It is also true*

for this sample, Accumulation of elements has been observed largely in the epidermal outer cortical layer of the root crossections.

27. *L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM16 (zamx_w295_33-regions-PIXE).*

File Name: zamx_w295_33.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1205 µC
Scan: X= 334 µm, Y= 333 µm
Pixel: X size: 128, Y Size: 128



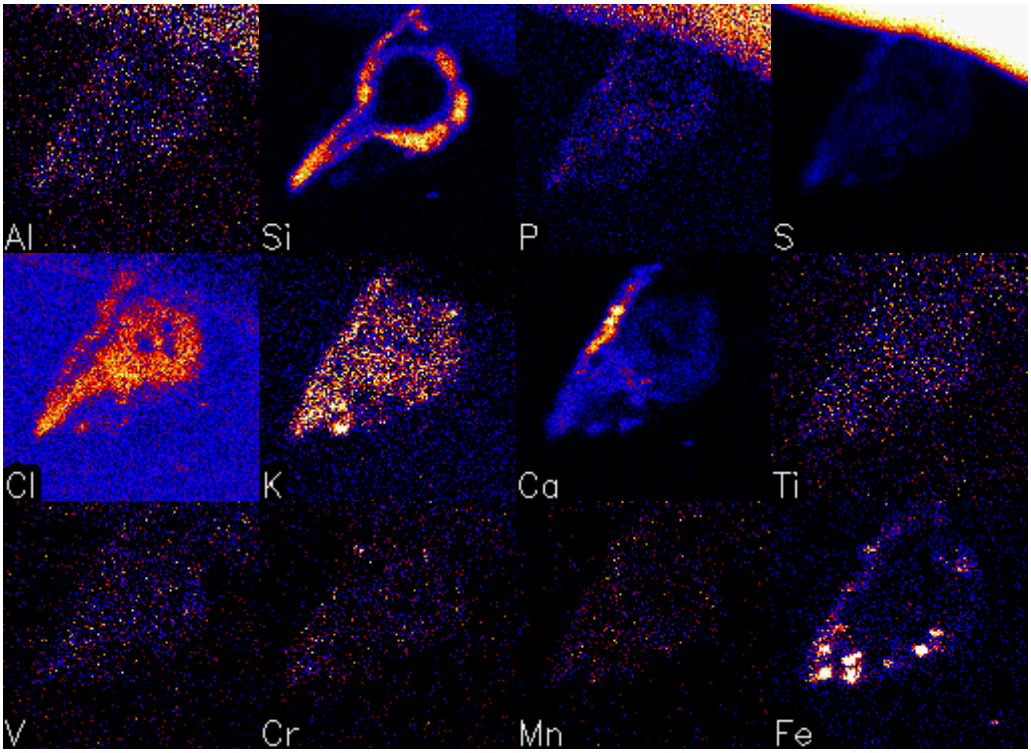
Relative Concentration Legend

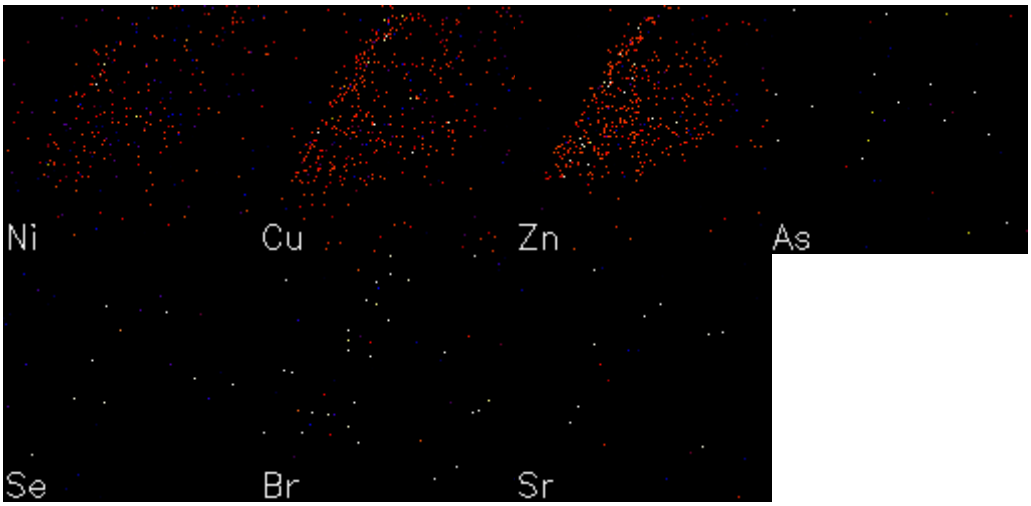
Zero  Maximum

Fig 3.5.33: L4 R1 4A - North West (Rustenburg) Lonmin Platinum Mine (L) REM16 (zamx_w295_33-regions-PIXE). Al, Ca, Cl, Cu, Fe, S, Zn, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While K and P appear to be spread across the root cross-section.

28. *WW14 (7a) R1 Cross – West Wits (Gauteng) high Au +Ur Reg 0 -3 REM17 (zamx_w295_34-regions-PIXE).*

File Name: zamx_w295_34.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1802 µC
Scan: X= 417 µm, Y= 407 µm
Pixel: X size: 128, Y Size: 124





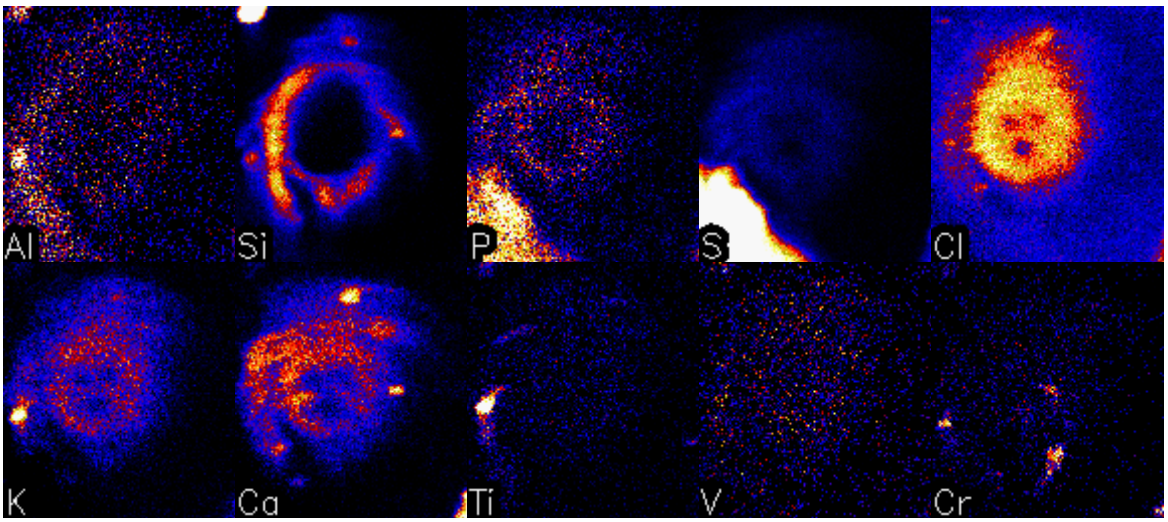
Relative Concentration Legend

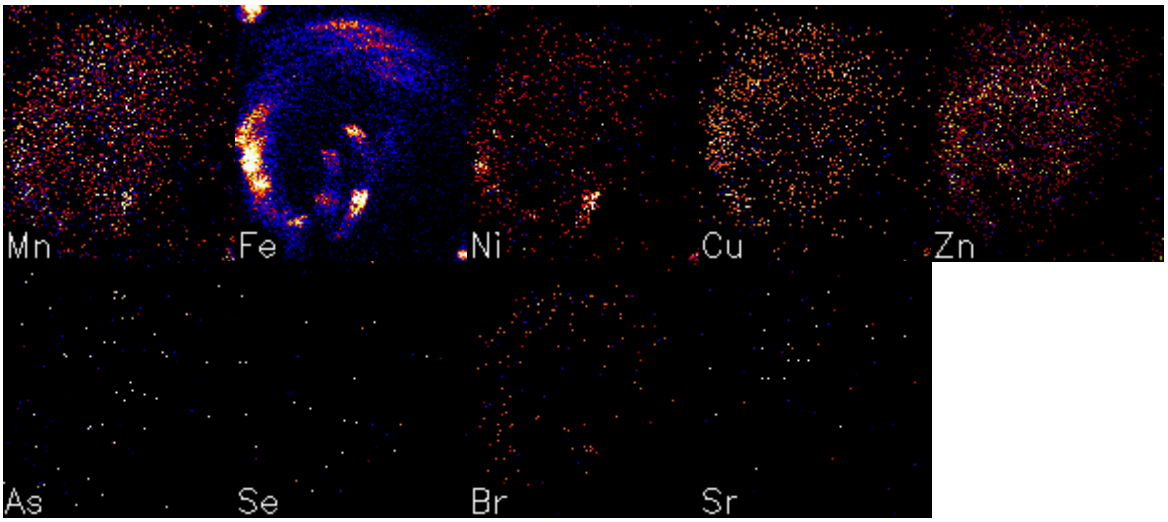
Zero  Maximum

Fig 3.5.34: WW14 (7a) R1 Cross – West Wits (Gauteng) high Au +Ur Reg 0 -3 REM17 (zamx_w295_34-regions-PIXE). Ca, Fe, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, and K appear to be spread across the root cross-section.

29. *WW14 (7a) R1 Cross – West Wits (Gauteng) high Au +Ur Reg 0 -3 REM18 (zamx_w295_35-regions-PIXE).*

File Name: zamx_w295_35.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2467 µC
Scan: X= 302 µm, Y= 334 µm
Pixel: X size: 116, Y Size: 128





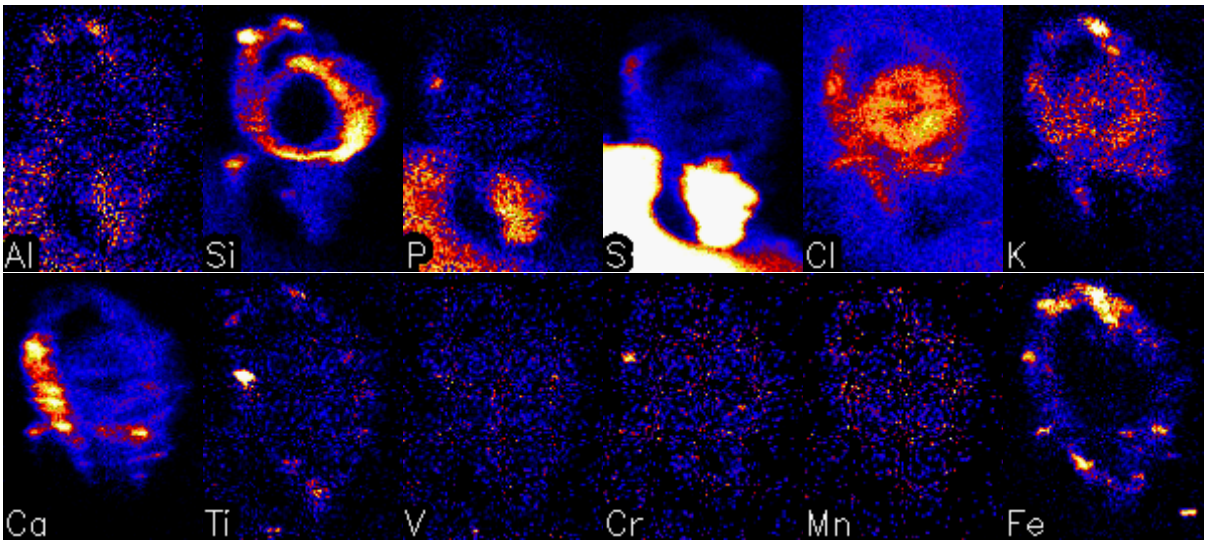
Relative Concentration Legend

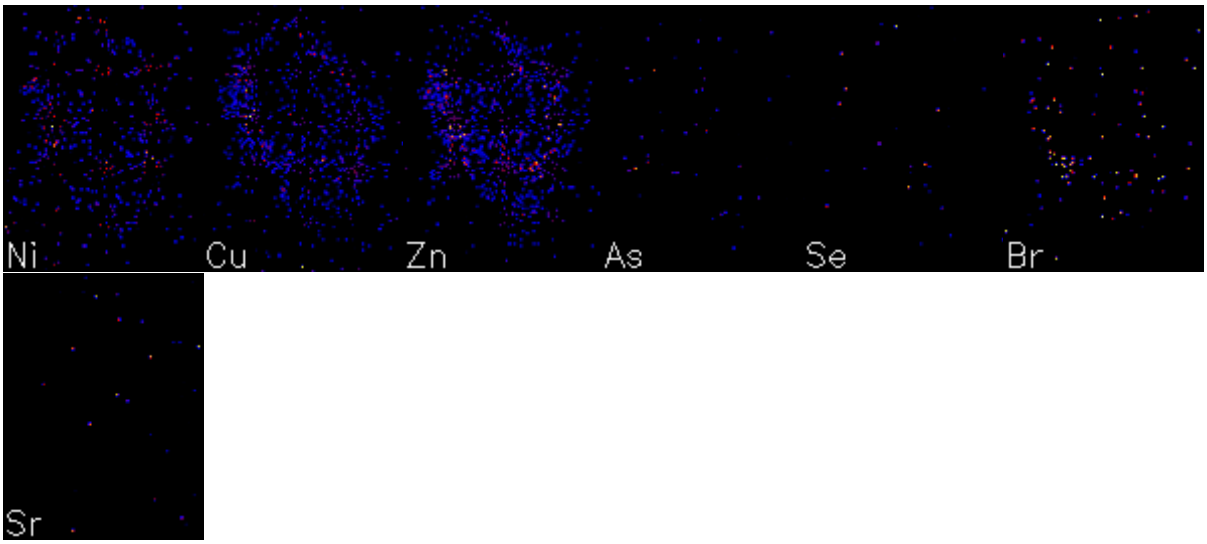
Zero Maximum

Fig 3.5.35: WW14 (7a) R1 Cross – West Wits (Gauteng) high Au +Ur Reg 0 -3 REM18 (zamx_w295_35-regions-PIXE). Al, Ca, Cr, Fe, K, Mn, Ni, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Cu, and Zn, appear to be spread across the root cross-section.

30. *WW14 (7a) R1 Cross – West Wits (Gauteng) high Au +Ur Reg. 0 -3 REM19 (zamx_w295_36-regions-PIXE).*

File Name: zamx_w295_36.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1391 µC
Scan: X= 319 µm, Y= 417 µm
Pixel: X size: 96, Y Size: 128





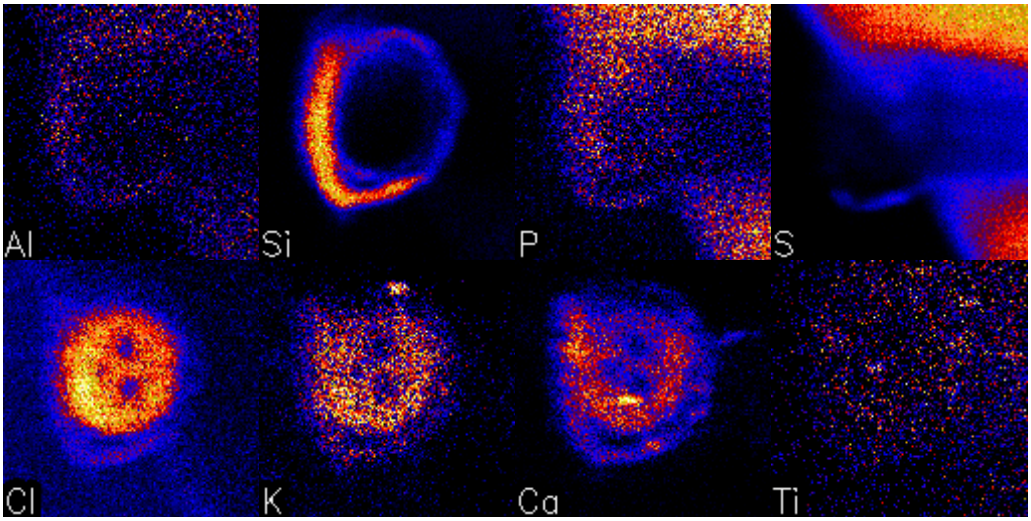
Relative Concentration Legend

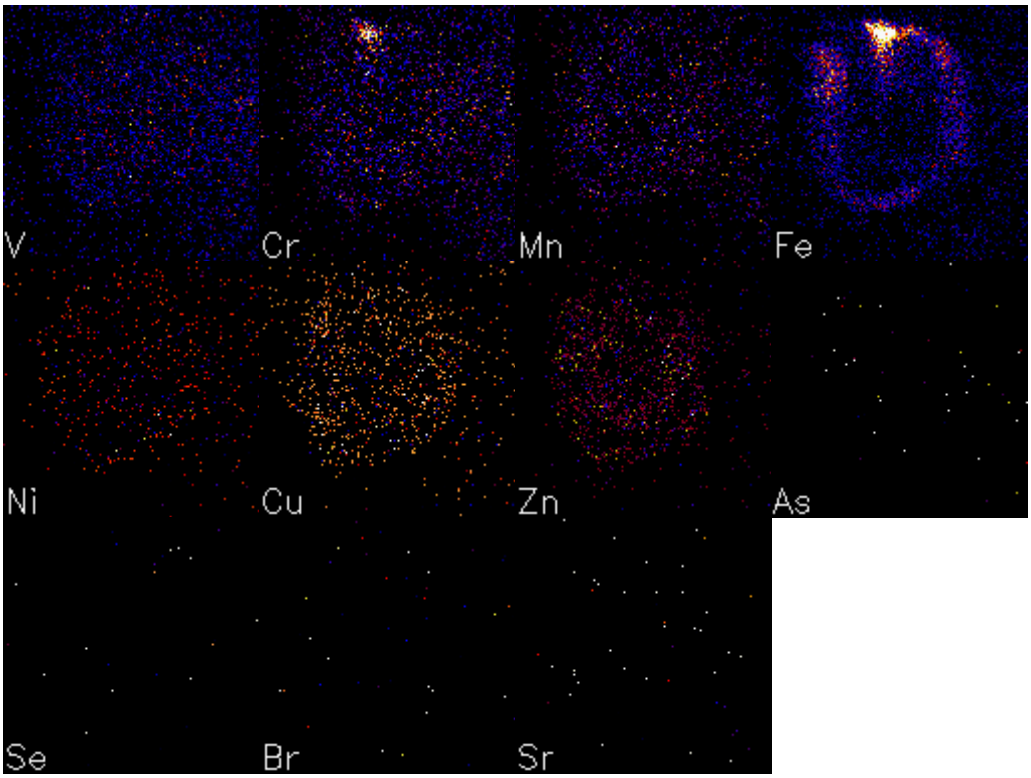
Zero Maximum

Fig 3.5.36: WW14 (7a) R1 Cross – West Wits (North West) high Au +Ur Reg. 0 -3 REM19 (zamx_w295_36-regions-PIXE). Al, Ca, Cr, Fe, Mn, P, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, and K appear to be spread across the root cross-section.

31. *WW14 (7a) R1 Cross – West Wits (North West) high Au +Ur Reg. 0 -3 REM20 (zamx_w295_37-regions-PIXE).*

File Name: zamx_w295_37.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1352 µC
Scan: X= 251 µm, Y= 250 µm
Pixel: X size: 128, Y Size: 128





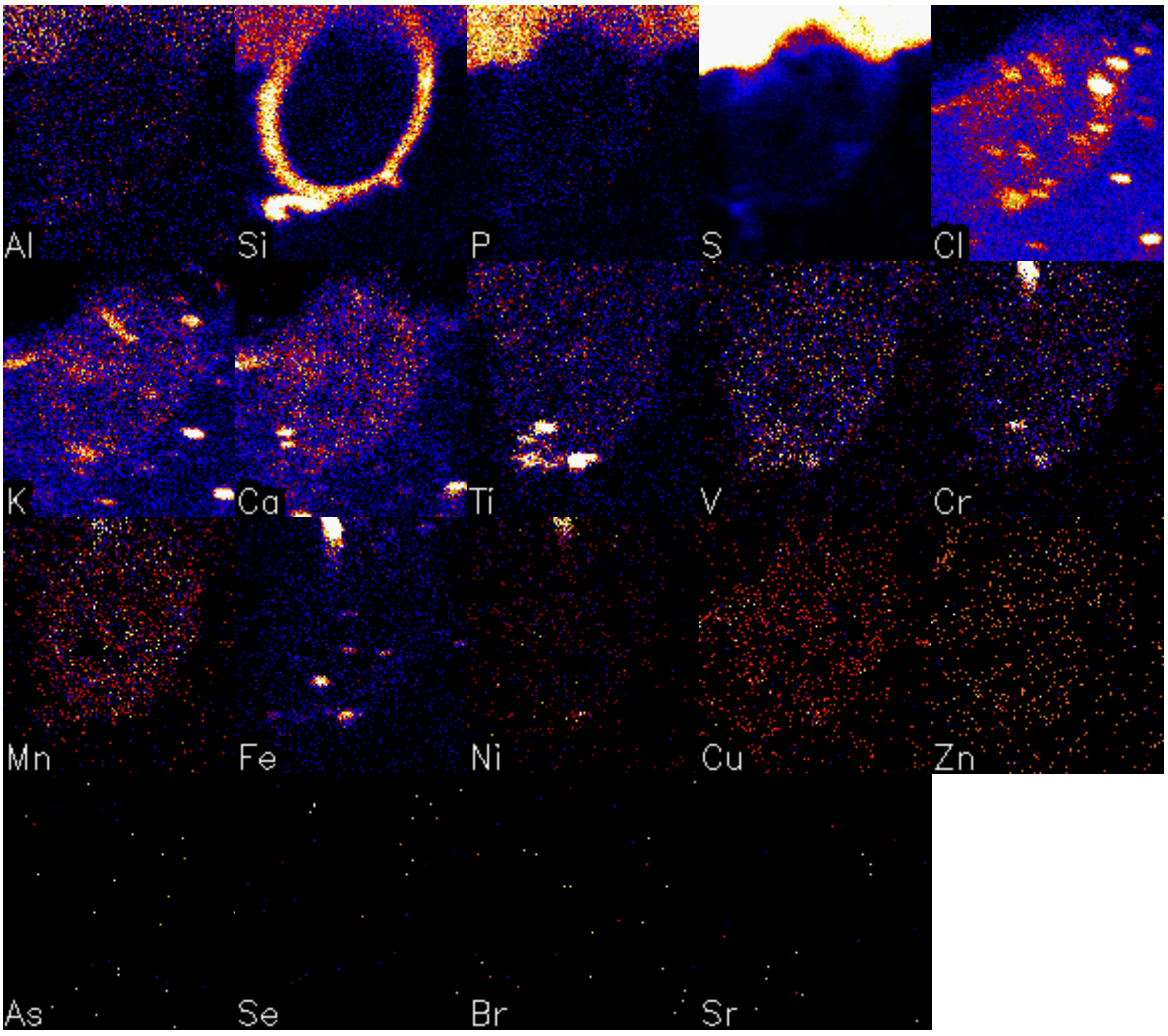
Relative Concentration Legend

Zero Maximum

Fig 3.5.37: WW14 (7a) R1 Cross – West Wits (North West) high Au +Ur Reg. 0 -3 REM20 (zamx_w295_37-regions-PIXE). Ca, Cr, Fe, K, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, and K, appear to be spread across the root cross-section.

32.*Ctr + Nu R2 (4) Cross Rem 21 (zamx_w295_38-regions-PIXE).*

File Name: zamx_w295_38.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1822 µC
Scan: X= 303 µm, Y= 334 µm
Pixel: X size: 116, Y Size: 128



Relative Concentration Legend

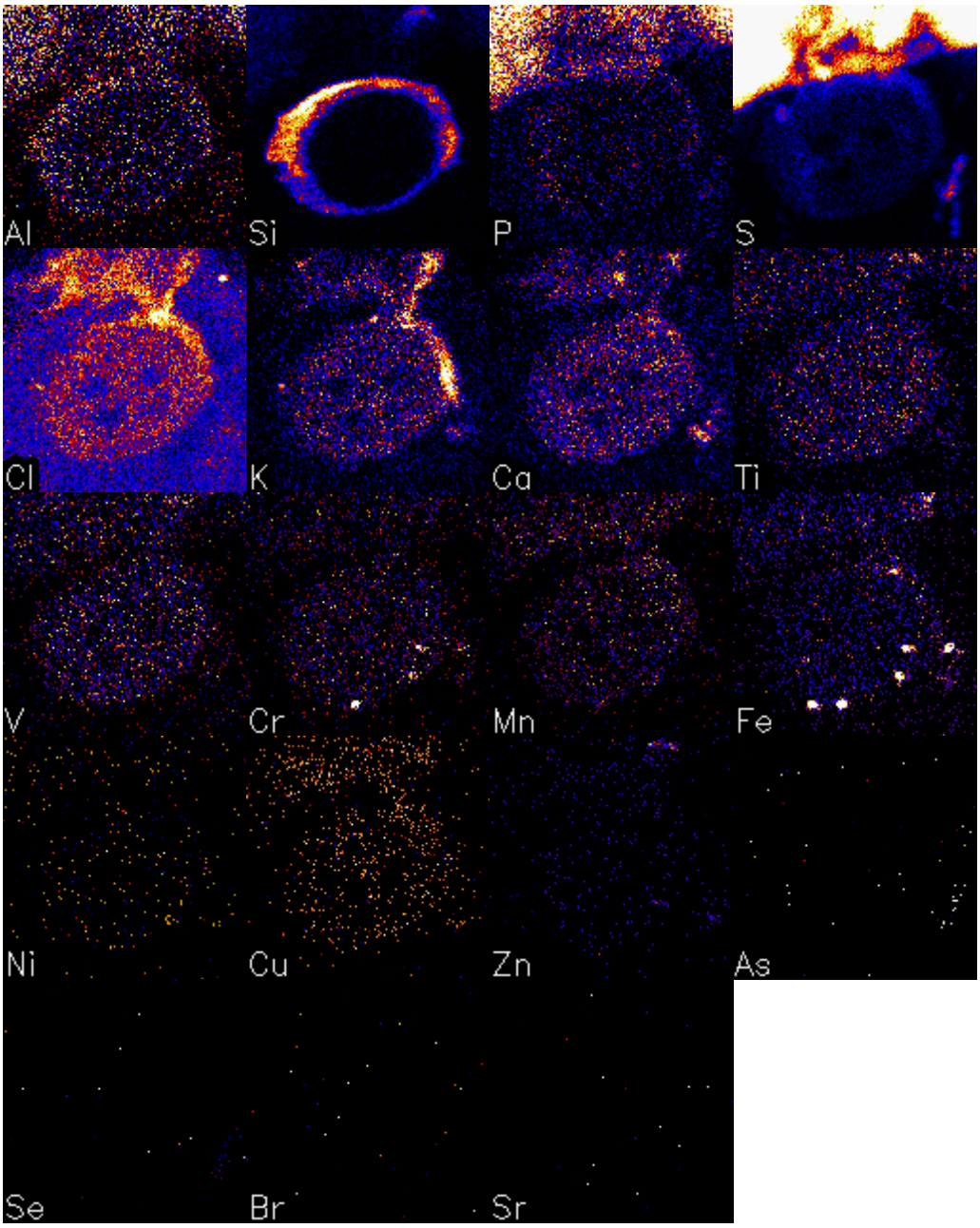
Zero Maximum

Fig 3.5.38: Ctr + Nu R2 (4) Cross Rem 21 (zamx_w295_38-regions-PIXE). Ca, Cl, Cr, Fe, K, Ni, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. *Since this sample is a control with no AMF spores added, metal concentration was not expected. Thus the presence of AMF structures observed is a surprise.*

33.*Ctr + Nu R2 (4) Cross Rem 22 (zamx_w295_40-regions-PIXE).*

File Name: zamx_w295_40.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1250 µC
Scan: X= 417 µm, Y= 417 µm

Pixel: X size: 128, Y Size: 128



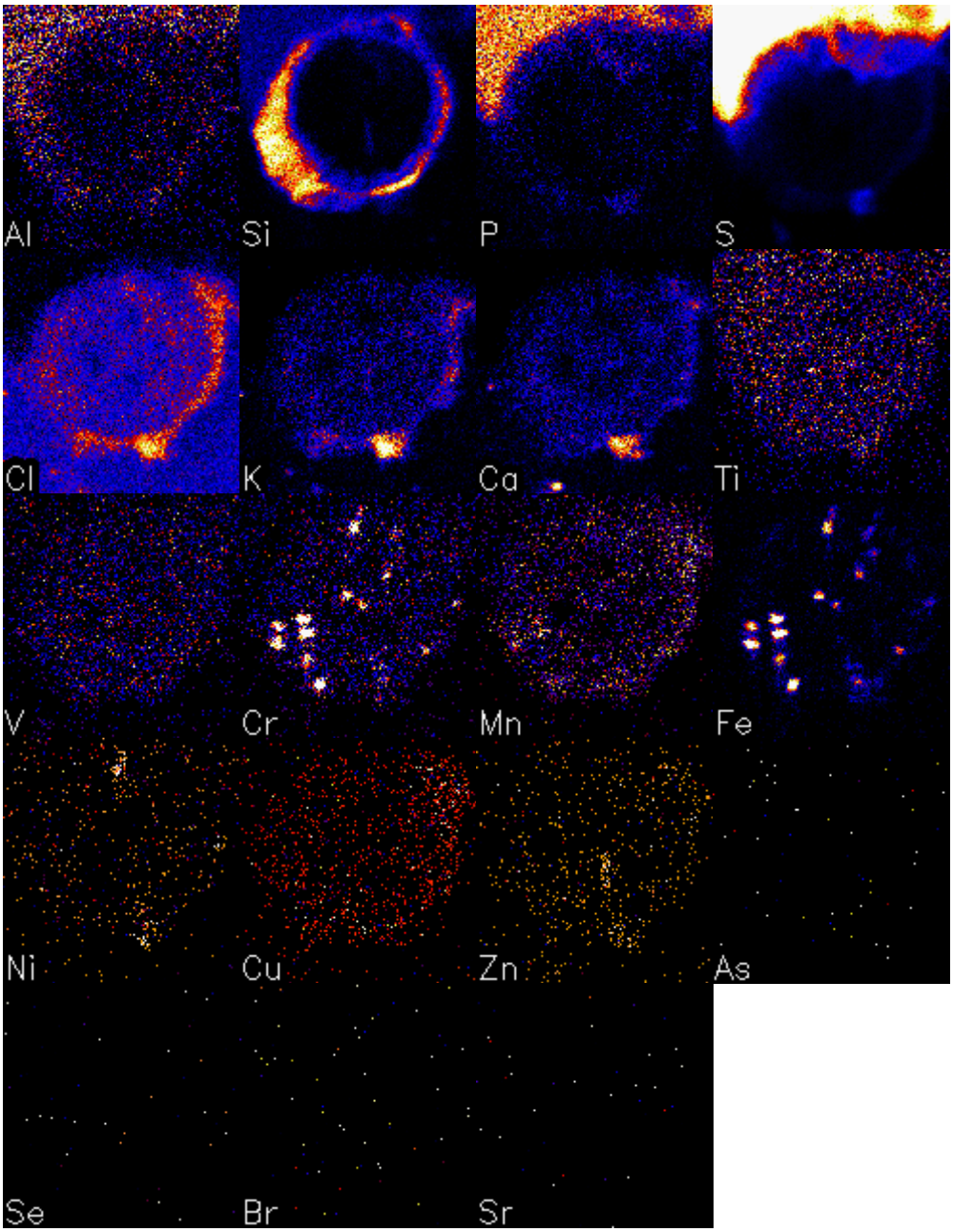
Relative Concentration Legend

Zero  Maximum

Fig 3.5.39: Ctr + Nu R2 (4) Cross Rem 22 (zamx_w295_40-regions-PIXE). Ca, Cl, Cr, Fe, K, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. *Since this sample is a control with no AMF spores added, metal concentration was not expected. Thus the presence of AMF structures observed is a surprise.*

34. *Ctr + Nu R2 (4) Cross Rem 23 (zamx_w295_41-regions-PIXE).*

File Name: zamx_w295_41.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1664 µC
Scan: X= 328 µm, Y= 333 µm
Pixel: X size: 124, Y Size: 128



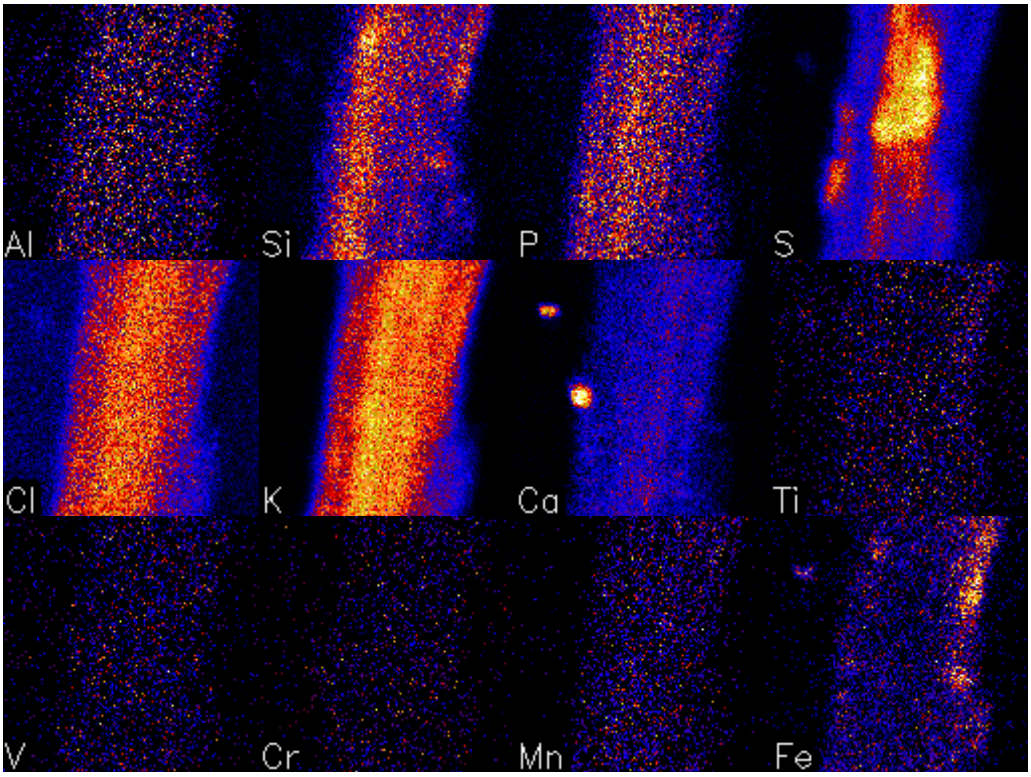
Relative Concentration Legend

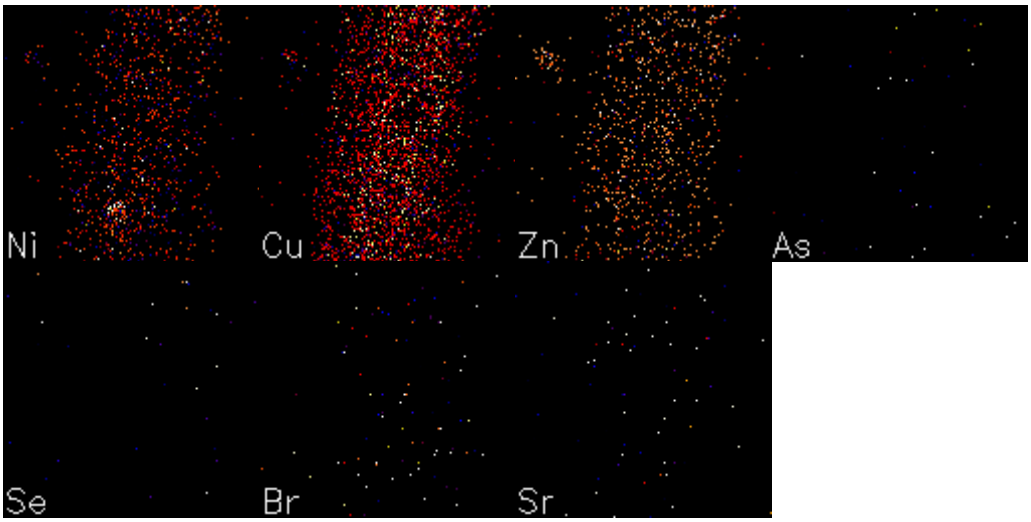


Fig 3.5.40: Ctr + Nu R2 (4) Cross Rem 23 (zamx_w295_41-regions-PIXE). Ca, Cl, Cr, Fe, K, Mn, Ni, Ti and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. *Since this sample is a control with no AMF spores added, metal concentration was not expected. Thus the presence of AMF structures observed is a surprise.*

35. *Ctr + Myco 8 R1 Rem 24 (zamx_w290_42-regions-PIXE).*

File Name: zamx_w295_42.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1142 µC
Scan: X= 226 µm, Y= 250 µm
Pixel: X size: 128, Y Size: 128





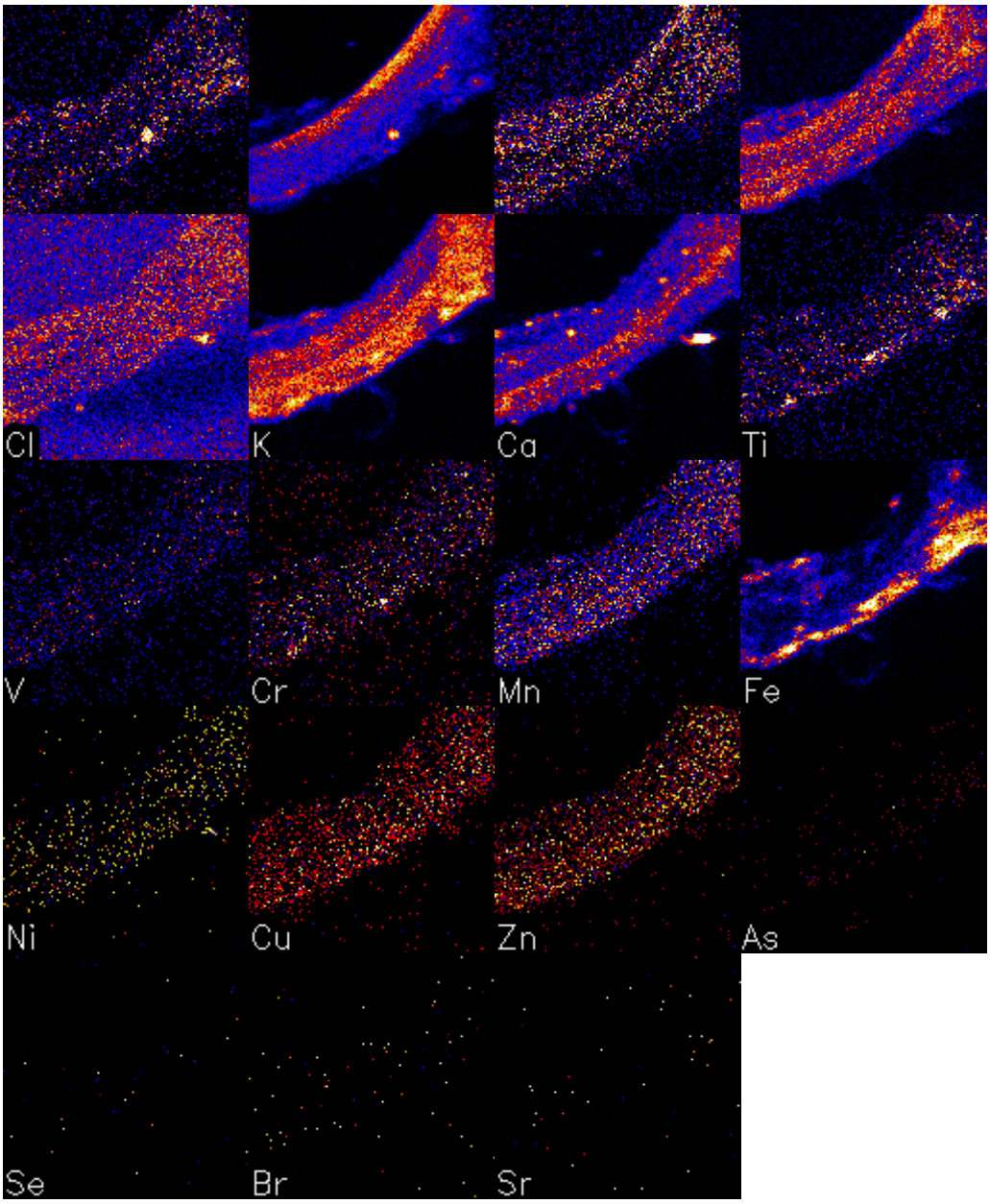
Relative Concentration Legend

Zero Maximum

Fig 3.5.41: Ctr + Myco 8 R1 Rem 24 (zamx_w290_42-regions-PIXE). Ca, Fe, and Ni, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, S, P, Si and K, appear to be spread across the root cross-section. *More accumulation of elements in the AMF structures was expected since this sample was inoculated with mycoroots, but the elemental concentration appears to be lesser that* ***Ctr + Nu***

36. *North West (Vaal Reefs) Au +Ur) S11 R2 (2) Rem 25 (zamx_w295_43-regions-PIXE).*

File Name: zamx_w295_43.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1545 µC
Scan: X= 417µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128



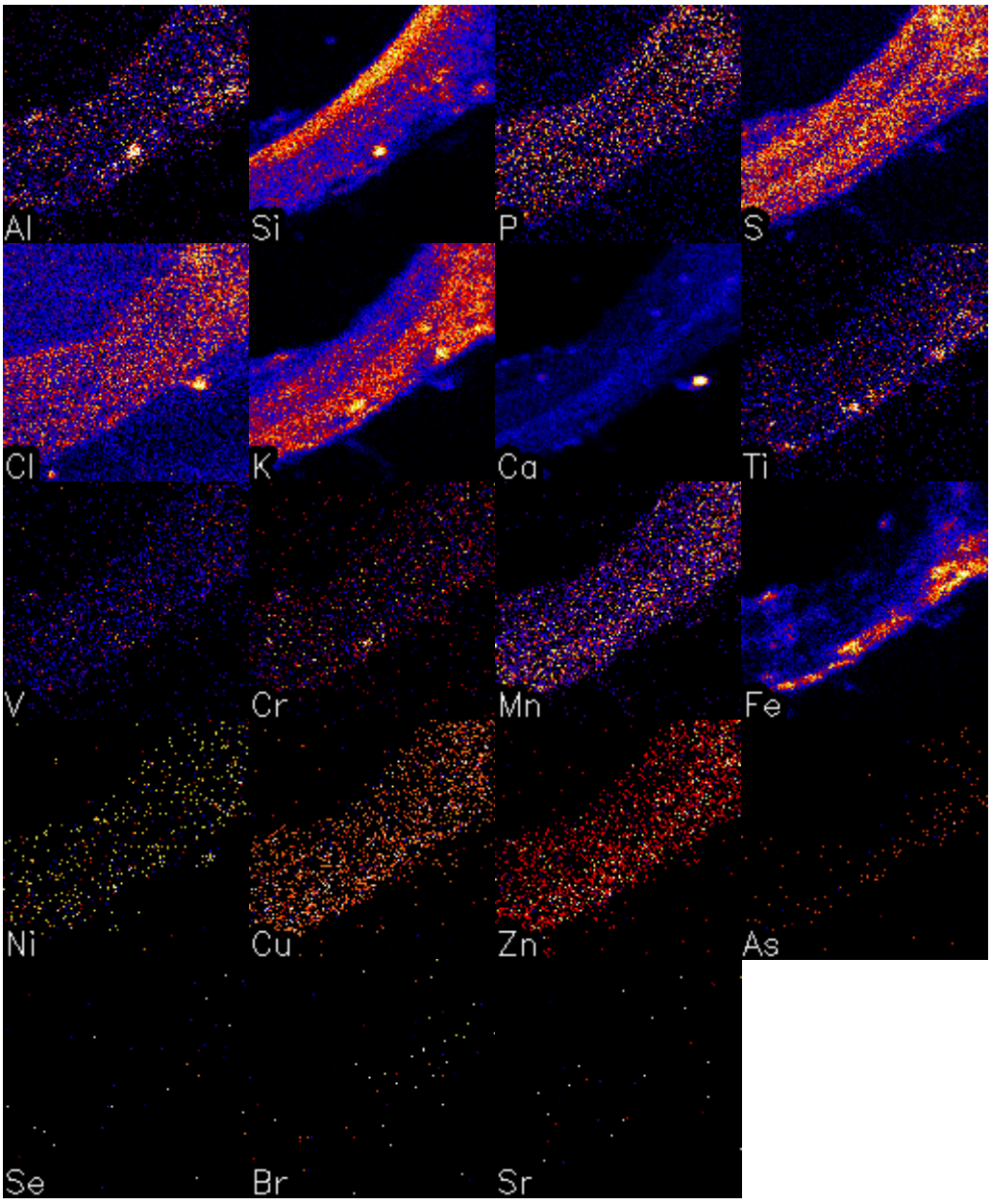
Relative Concentration Legend



Fig 3.5.42: North West (Vaal Reefs) Au +Ur) S11 R2 (2) Rem 25 (zamx_w295_43-regions-PIXE). Al, Ca, Cr, Fe, Mn, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Cu, P, K, S, and Zn, appear to be spread across the root cross-section.

37. North West (Vaal Reefs) Au +Ur) S11 R2 (2) Rem 8 Repeat of Fig 3.5.44 (zamx_w295_47-regions-PIXE).

File Name: zamx_w295_47.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 884 µC
Scan: X= 334 µm, Y= 323 µm
Pixel: X size: 128, Y Size: 124



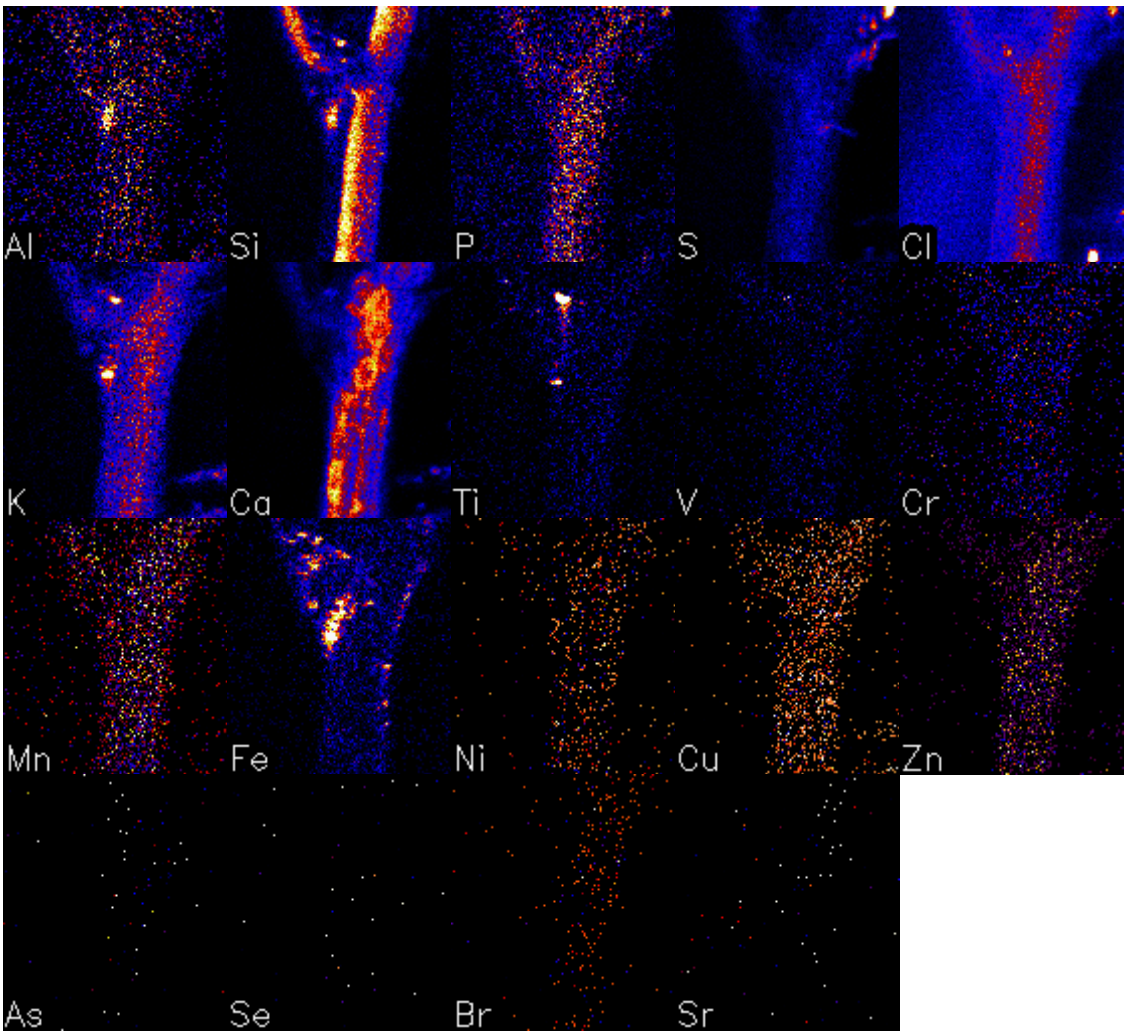
Relative Concentration Legend



Fig 3.5.43: North West (Vaal Reefs) Au +Ur) S11 R2 (2) Rem 8 Repeat of Fig 3.5.44 (zamx_w295_47-regions-PIXE). Al, Ca, Cr, Fe, Mn, Ti, and were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Cu, P, K, S, Si and Zn, appear to be spread across the root cross-section.

38. WW14 (3) R1 Cross – West Wits (Gauteng) high Au +Ur Reg 0 -2 REM9 (zamx_w295_48-regions-PIXE).

File Name: zamx_w295_48.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2280 µC
Scan: X= 450 µm, Y= 501 µm
Pixel: X size: 112, Y Size: 128



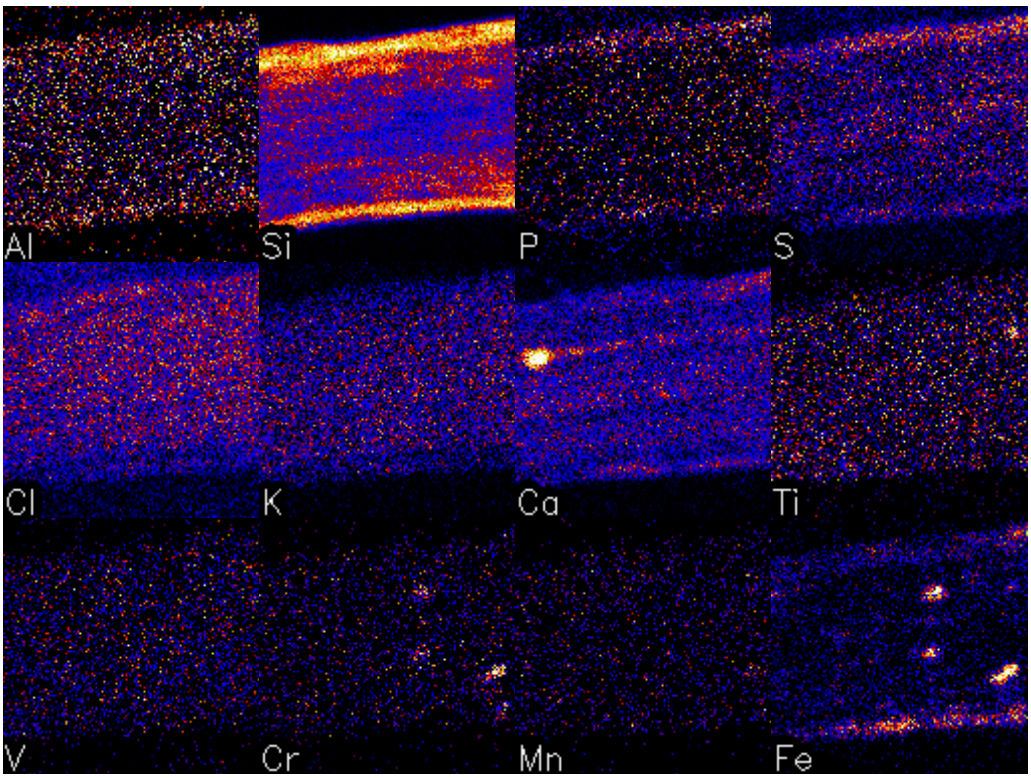
Relative Concentration Legend

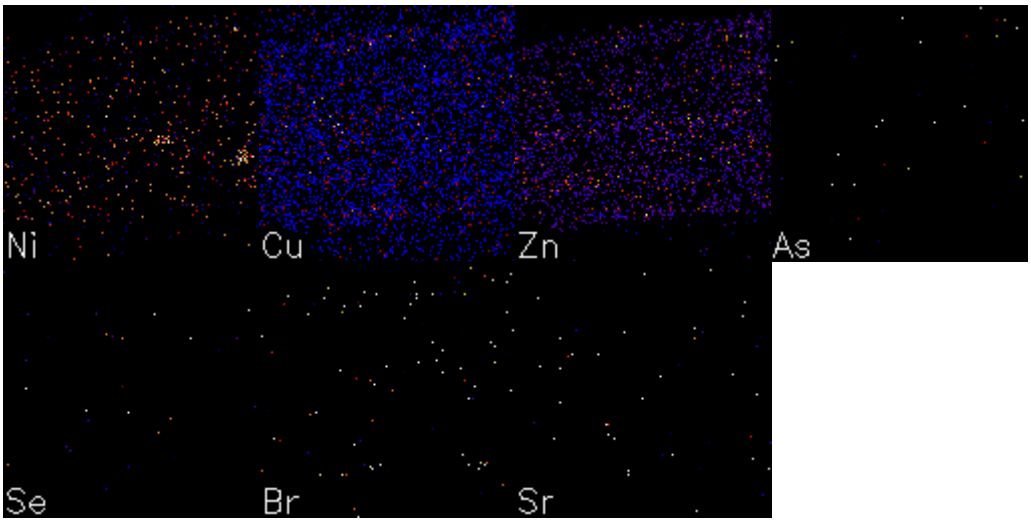
Zero  Maximum

Fig 3.5.44: WW14 (3) R1 Cross – West Wits (North West) high Au +Ur Reg 0 -2 REM9 (zamx_w295_48-regions-PIXE). Al, Ca, Fe, Mn, S, V and Ti, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Cu, P, K, Si and Zn, appear to be spread across the root cross-section.

39. East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1 Rem 10 (1) (zamx_w295_49-regions-PIXE).

File Name: zamx_w295_49.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1134 µC
Scan: X= 250 µm, Y= 250 µm
Pixel: X size: 128, Y Size: 128





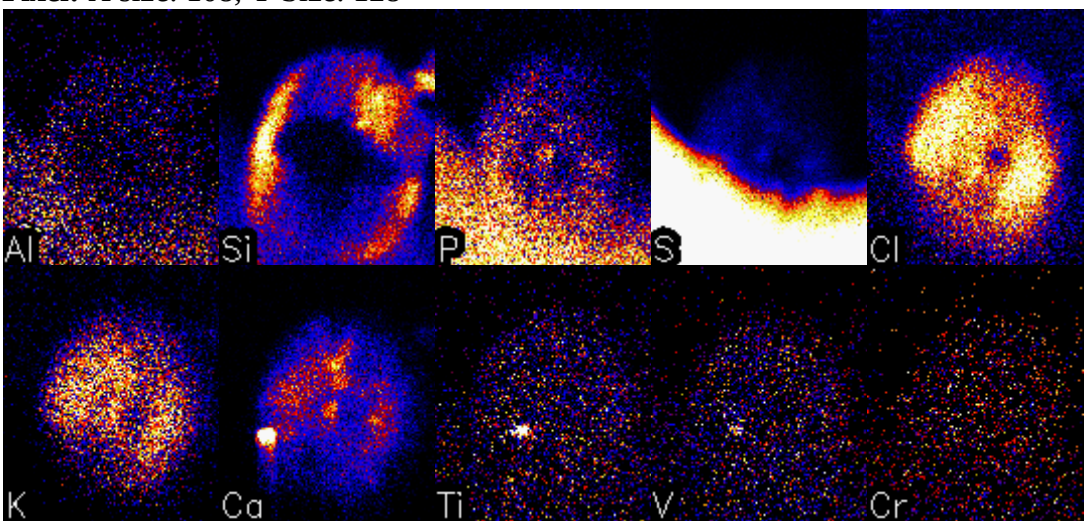
Relative Concentration Legend

Zero Maximum

Fig 3.5.45: East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1 Rem 10 (1) (zamx_w295_49-regions-PIXE). Ca, Cr, Fe, and Mn, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, K, and Si appear to be spread across the root cross-section.

40. East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1Reg 0 - 2 Rem 11 (1) (zamx_w295_50-regions-PIXE).

File Name: zamx_w295_50.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1104 µC
Scan: X= 213 µm, Y= 250 µm
Pixel: X size: 108, Y Size: 128



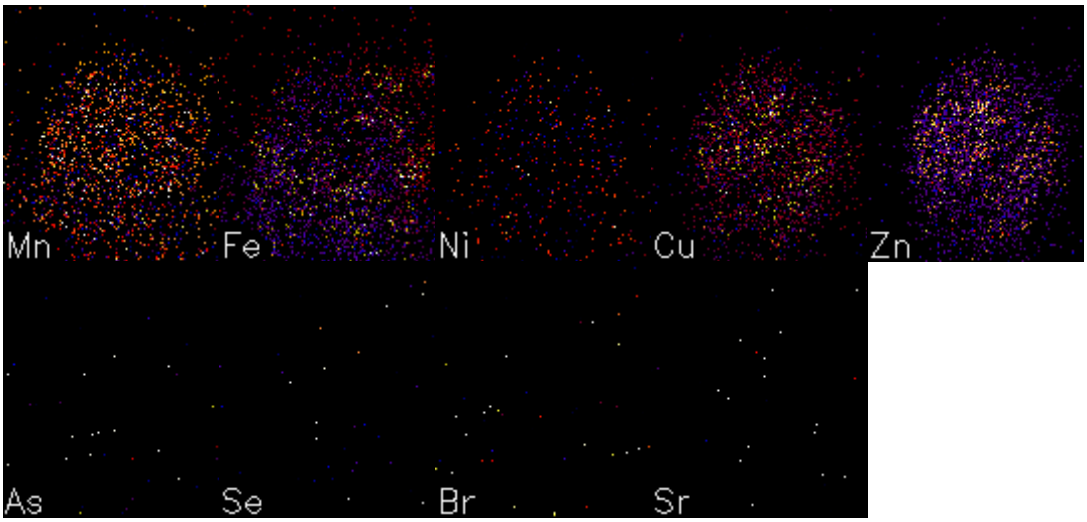
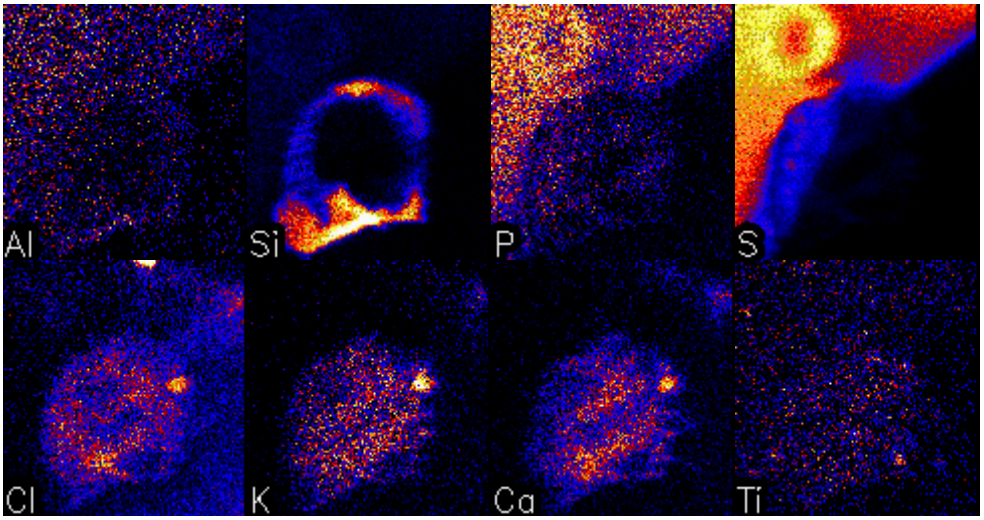


Fig 3.5.46: East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1Reg 0 - 2 Rem 11 (1) (zamx_w295_50-regions-PIXE). Ca, Ti and V, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, K, P and Si appear to be spread across the root cross-section.

41. East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1Reg 0 - 3 Rem 12 (1) (zamx_w295_51-regions-PIXE).

File Name: zamx_w295_51.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1356 µC
Scan: X= 321 µm, Y= 333 µm
Pixel: X size: 122, Y Size: 128



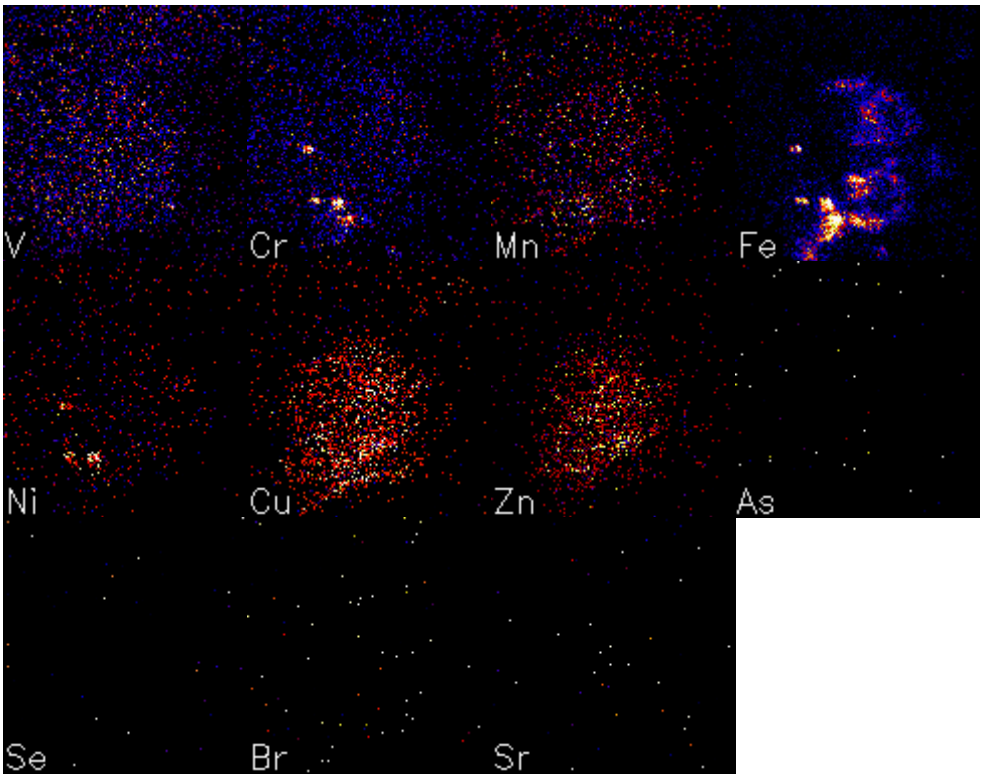
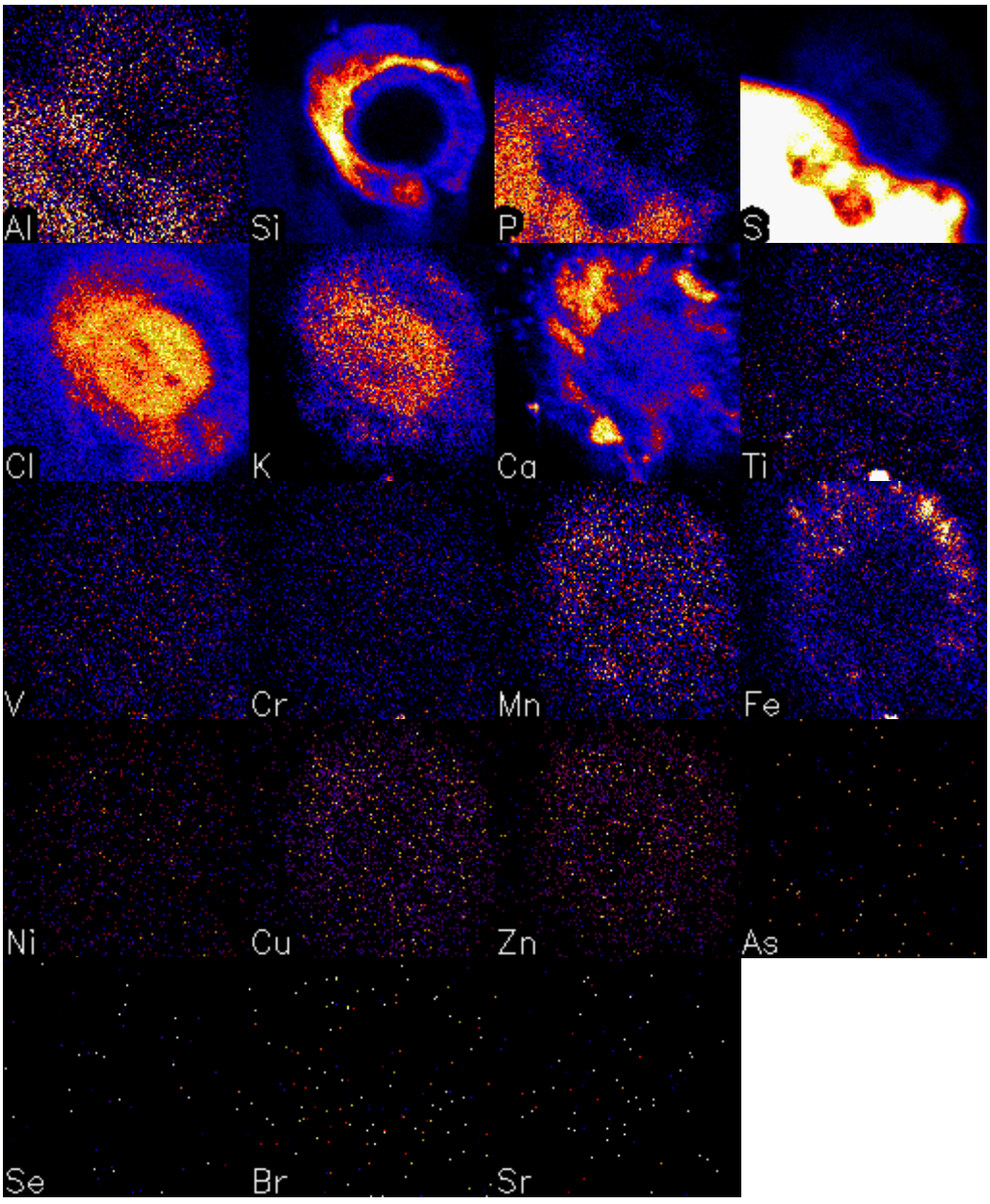


Fig 3.5.47: East Rand (ER) Metallurgical Plant (MP) A2 + A5 R1Reg 0 - 3 Rem 12 (1) (zamx_w295_51-regions-PIXE). Cr, Fe, Ni, Ti and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Ca, Cl, Mn, Cu, K, and Zn appear to be spread across the root cross-section.

42. M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -1 Rem 14 Cross (zamx_w295_52-regions-PIXE).

File Name: zamx_w295_52.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2848 µC
Scan: X= 295 µm, Y= 328 µm
Pixel: X size: 128, Y Size: 124



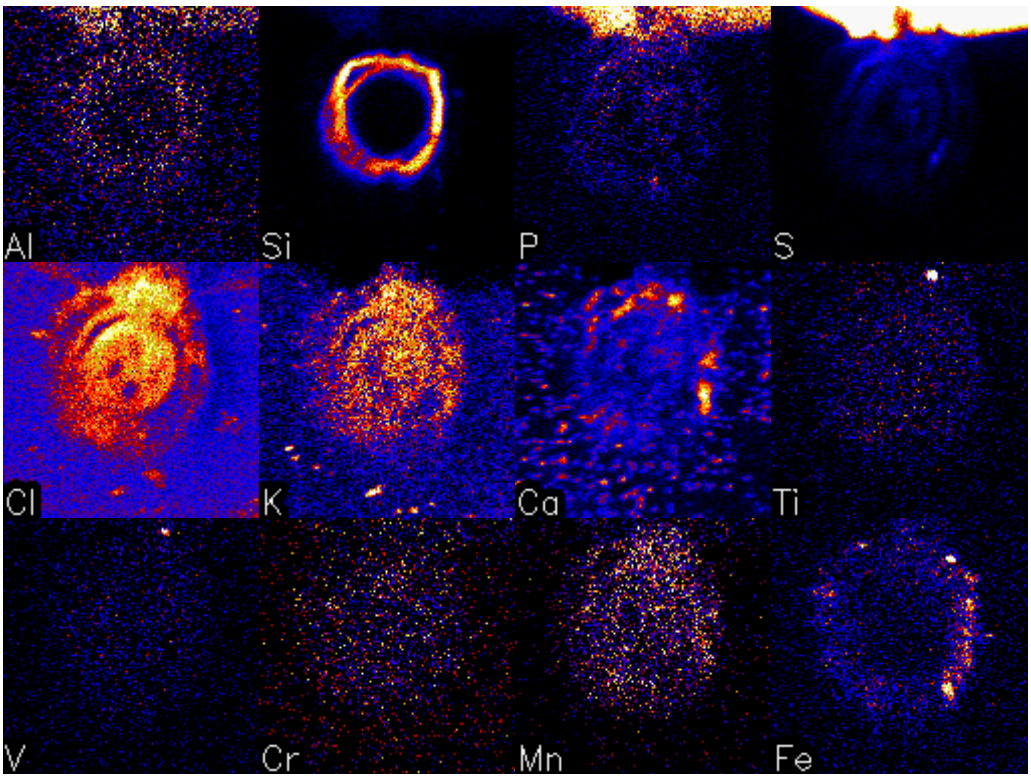
Relative Concentration Legend

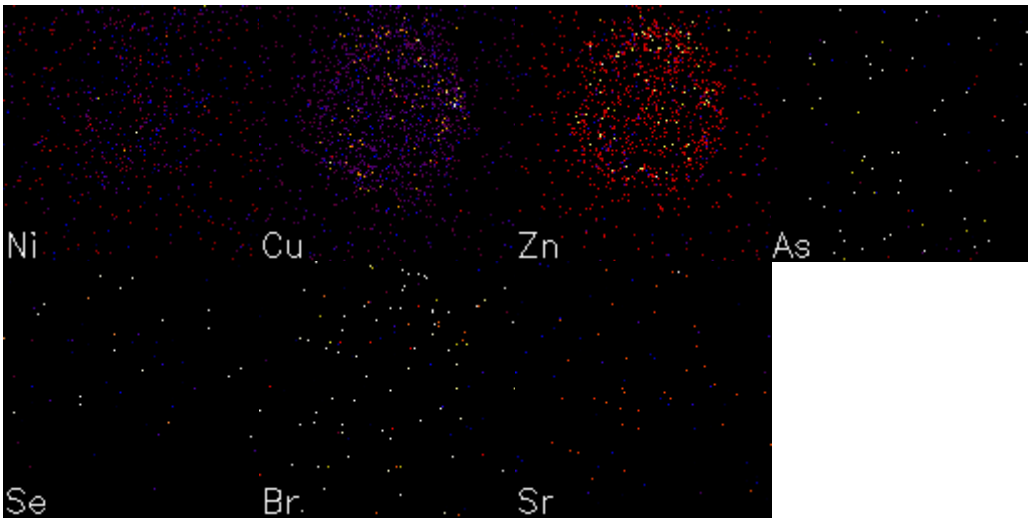
Zero  Maximum

Fig 3.5.48: (M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -1 Rem 14 Cross (zamx_w295_52-regions-PIXE). Ca, Fe, Mn, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Cu, Zn and K appear to be spread across the root cross-section.

43. (M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -2 Rem 15A Cross (zamx_w295_53-regions-PIXE).

File Name: zamx_w295_53.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 3225 µC
Scan: X= 417 µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128





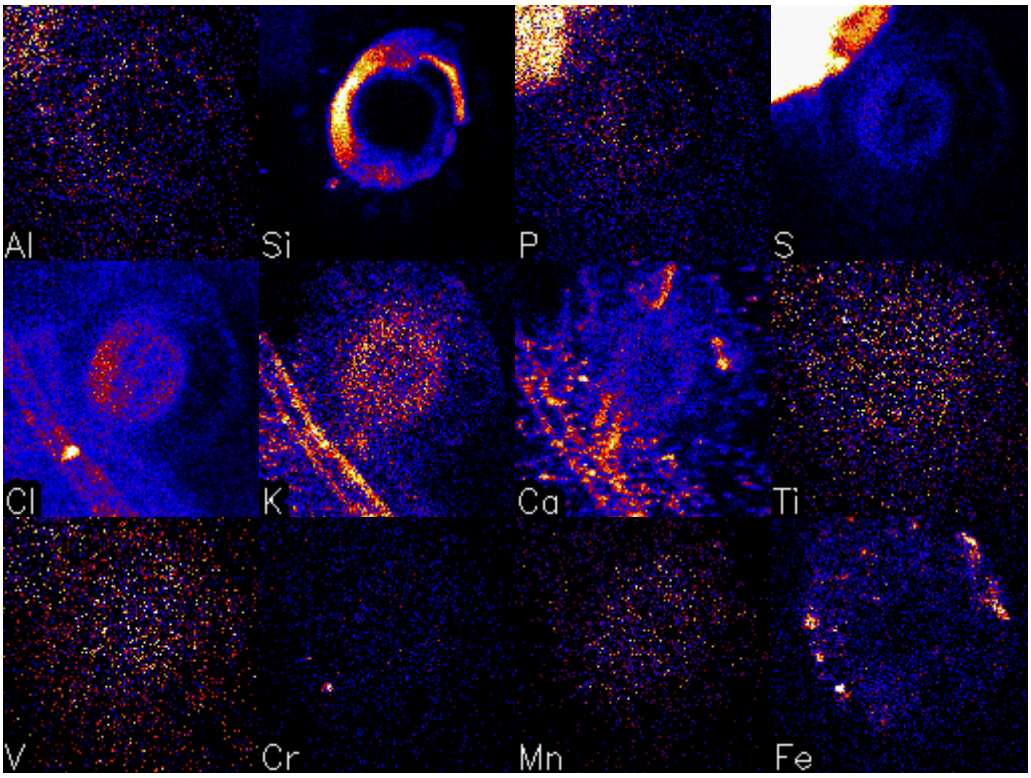
Relative Concentration Legend

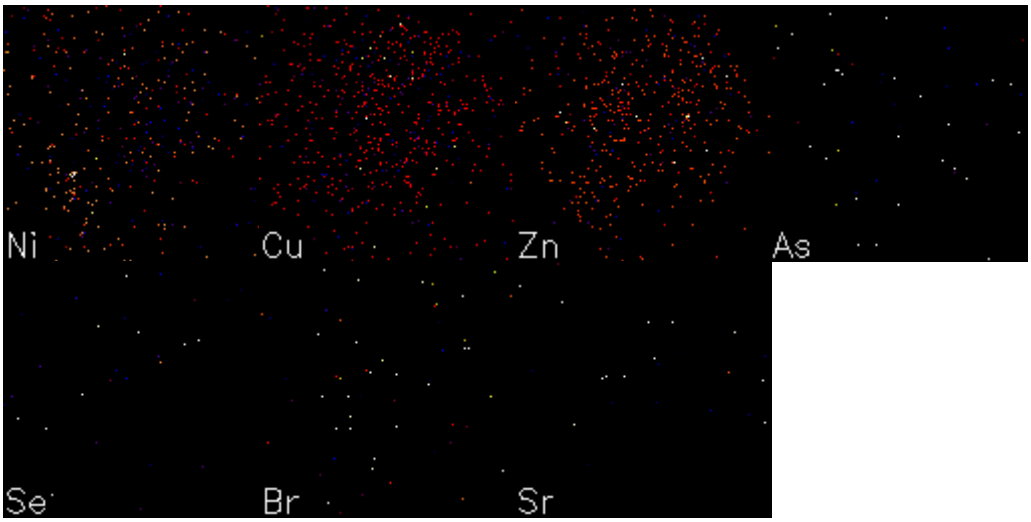
Zero  Maximum

Fig 3.5.49: (M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -2 Rem 15A Cross (zamx_w295_53-regions-PIXE). Ca, Fe, Ti and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, Mn, Cu, Zn and K appear to be spread across the root cross-section.

44. (M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -1 Rem 15B Cross (zamx_w295_54-regions-PIXE).

File Name: zamx_w295_54.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1368 µC
Scan: X= 417 µm, Y= 417 µm
Pixel: X size: 128, Y Size: 128





Relative Concentration Legend

Zero  Maximum

Fig 3.5.50: (M15 VR R (7)) North West (Vaal Reefs) Au +Ur) Reg 0 -1 Rem 15B Cross (zamx_w295_54-regions-PIXE). Ca, Cr, Fe, Cl and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Mn, Ti and K appear to be spread across the root cross-section.

45. Ctr + Mycoroot Reg 0 -3 Rem 16 Long Root (zamx_w295_55-regions-PIXE).

File Name: zamx_w295_55.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1138 µC
Scan: X= 318 µm, Y= 341 µm
Pixel: X size: 120, Y Size: 128

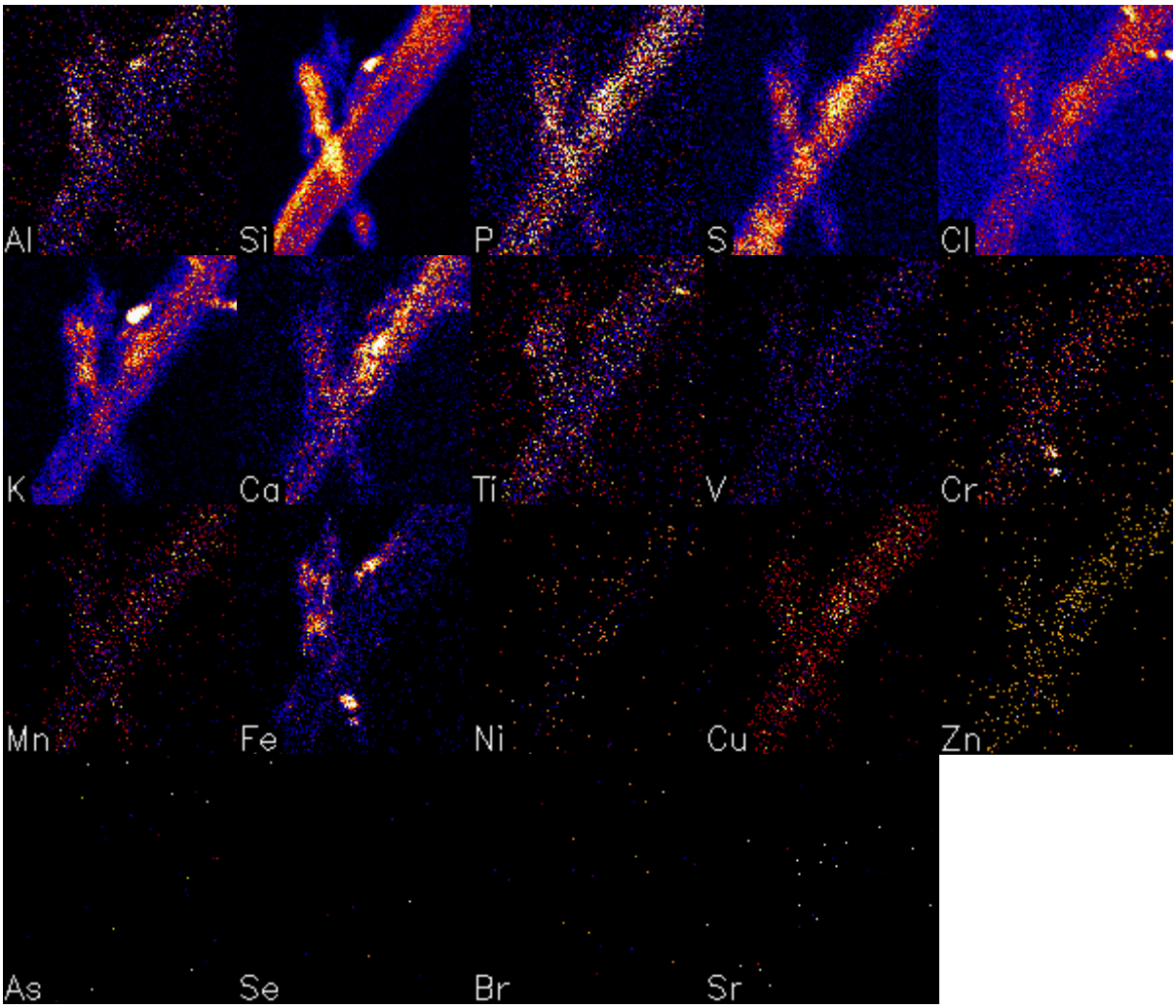
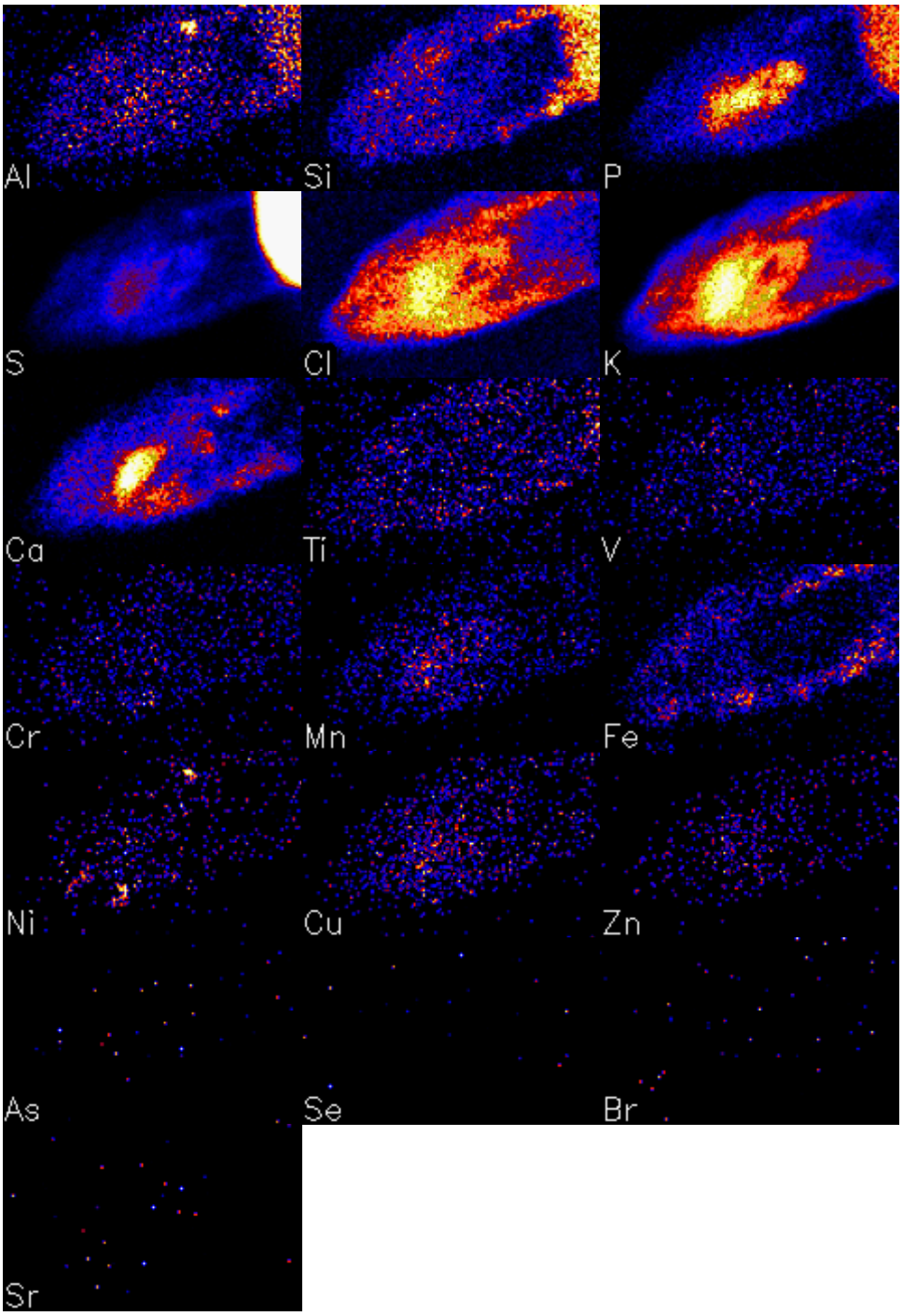


Fig 3.5.51: Ctr + Mycoroot Reg 0 -3 Rem 16 Long Root (zamx_w295_55-regions-PIXE). Ca, Cr, Fe, Ti, and K were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Al, Cl, P, S, and Si appear to be spread across the root cross-section.

46.Ctr + Mycoroot Reg 0 -3 Rem 17cross (zamx_w295_56-regions-PIXE).

File Name: zamx_w295_56.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1226 µC
Scan: X= 334 µm, Y= 216 µm
Pixel: X size: 128, Y Size: 80



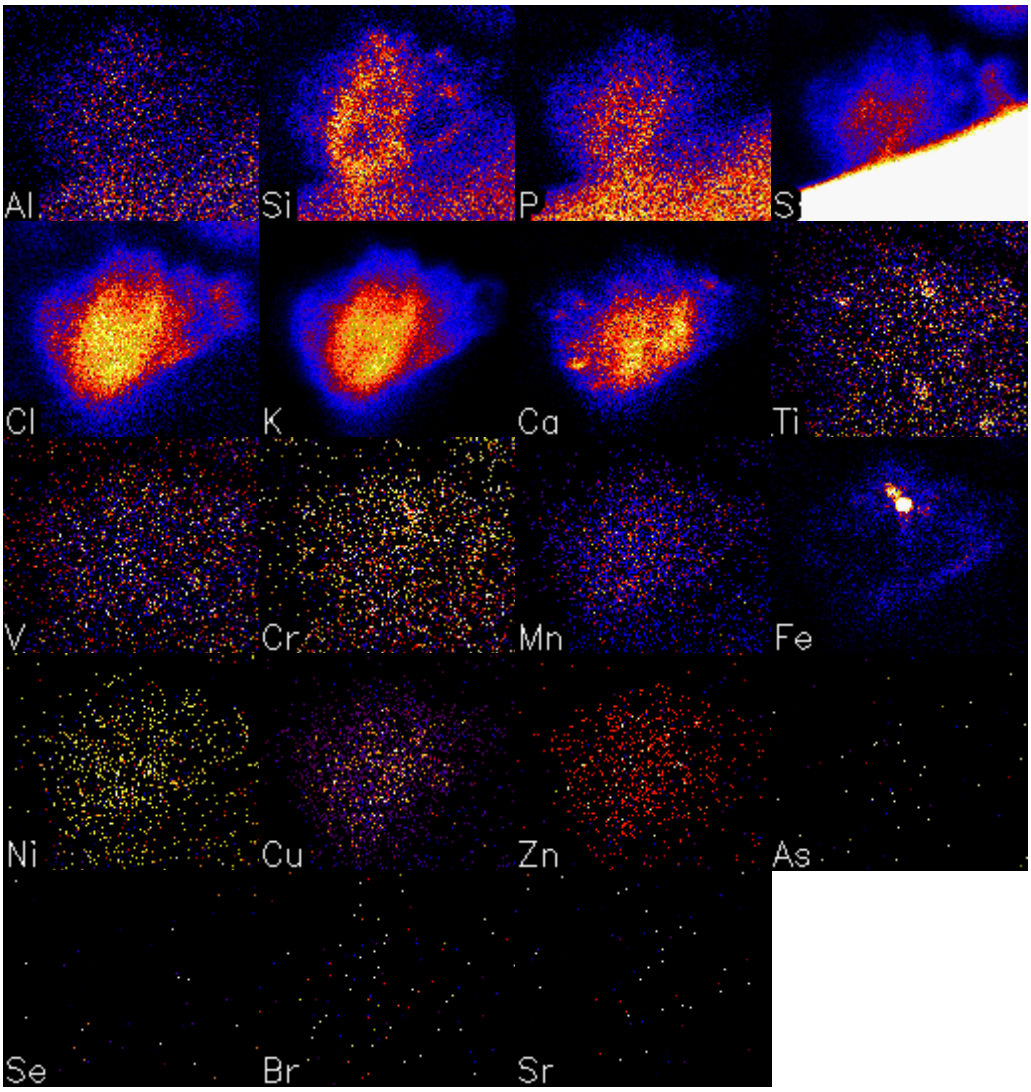
Relative Concentration Legend

Zero Maximum

Fig 3.5.52: Ctr + Mycoroot Reg 0 -3 Rem 17cross (zamx_w295_56-regions-PIXE). Al, Ca, Fe, and Ni, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, P, Cu, K and, Si appear to be spread across the root cross-section.

47.Ctr + Mycoroot Reg 0 -3 Rem 19 cross (zamx_w295_57-regions-PIXE).

File Name: zamx_w295_57.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2015 µC
Scan: X= 250 µm, Y= 215 µm
Pixel: X size: 128, Y Size: 108



Relative Concentration Legend



Fig 3.5.53: Ctr + Mycoroot Reg 0 -3 Rem 19 cross (zamx_w295_57-regions-PIXE). Fe, and Ti, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Ca, Cl, P, Mn, Cu, K and, Si appear to be spread across the root cross-section.

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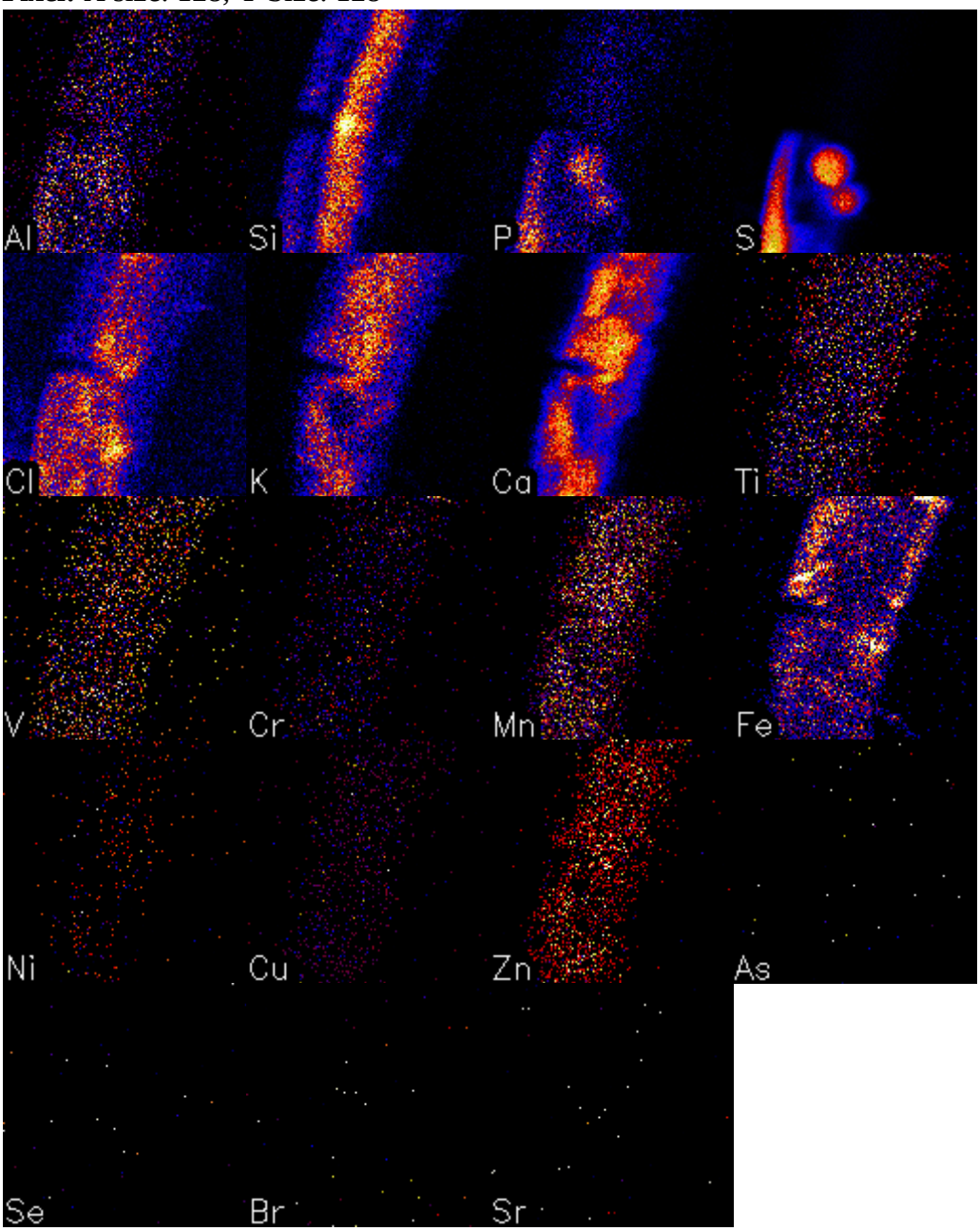
48. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) Reg 0 -3 Rem 20 long root (zamx_w295_58-regions-PIXE).

File Name: zamx_w295_58.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 899 µC
Scan: X= 334 µm, Y= 334 µm
Pixel: X size: 128, Y Size: 128



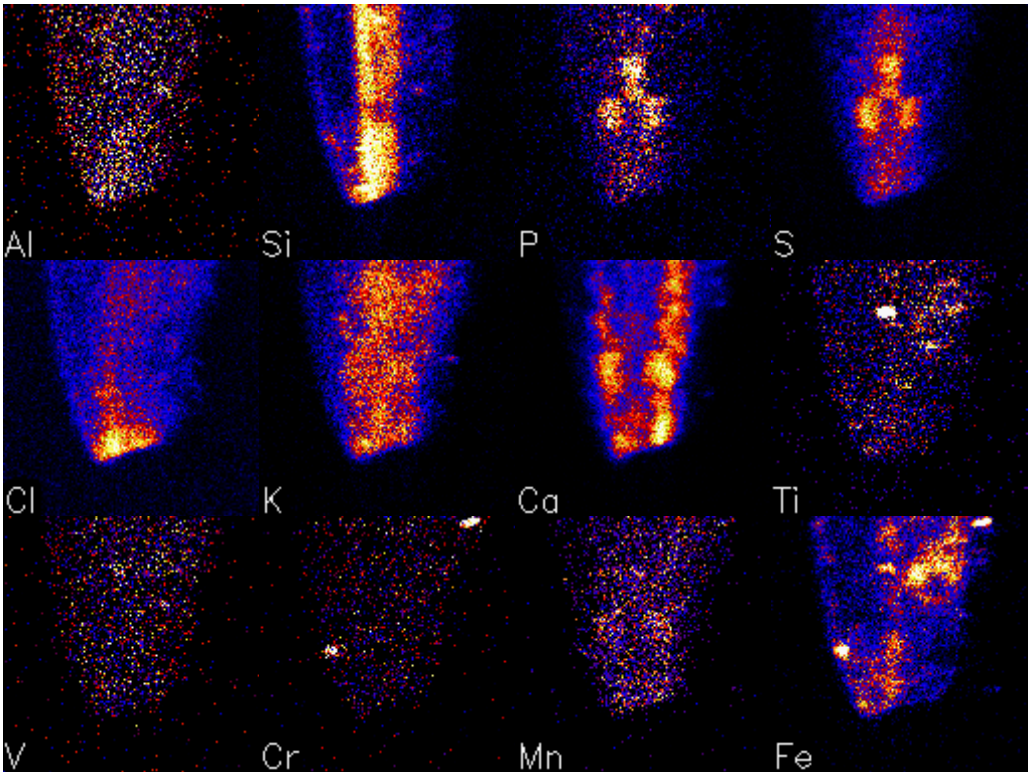
Relative Concentration Legend

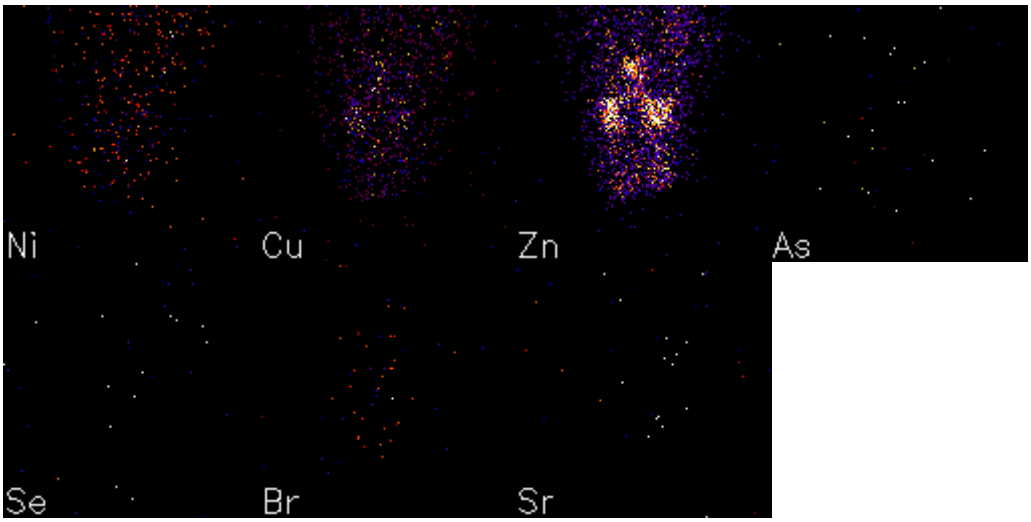
Zero  Maximum

Fig 3.5.54: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) Reg 0 -3 Rem 20 long root (zamx_w295_58-regions-PIXE). Ca, Cl, Fe, P, and S, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Al, Mn, K, Zn, and, Si appear to be spread across the root cross-section.

49. East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) Reg 0 -3 Rem 21 Long Root (zamx_w295_59-regions-PIXE).

File Name: zamx_w295_59.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1165 µC
Scan: X= 334 µm, Y= 334 µm
Pixel: X size: 128, Y Size: 128





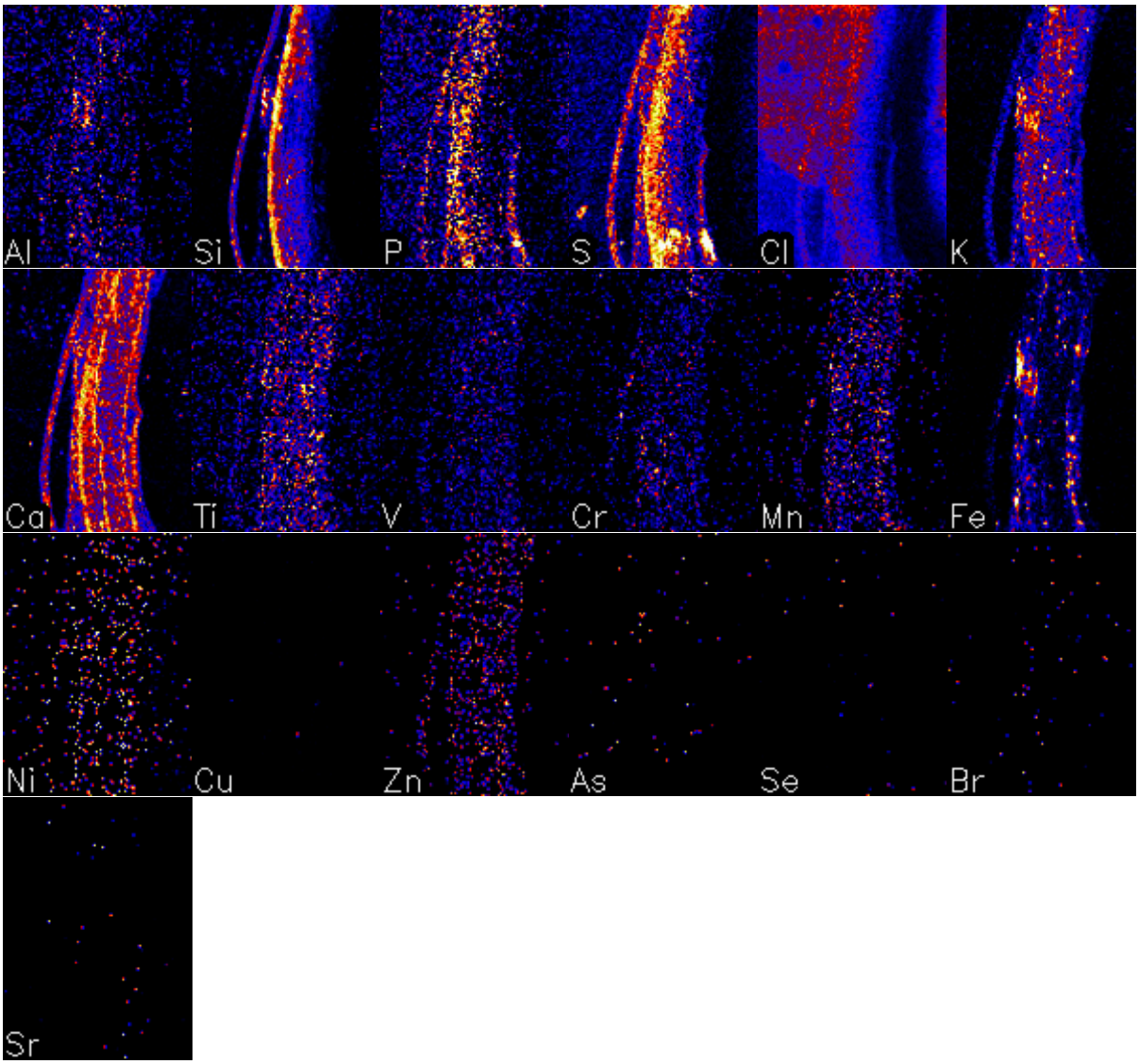
Relative Concentration Legend

Zero Maximum

Fig 3.5.55: East Rand (ER) Metallurgical Plant (MP) D1 R1 (6) (1) Reg 0 -3 Rem 21 Long Root (zamx_w295_59-regions-PIXE). Ca, Cl, Cr, Cu, Fe, Mn, P, Ti, Zn, and S, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Al, K and, Si appear to be spread across the root cross-section.

50. WW14 (3) R1 Long root – West Wits (North West) high Au +Ur Reg 0 -2 REM8 (zamx_w295_60-regions-PIXE).

File Name: zamx_w295_60.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1272 µC
Scan: X= 1053 µm, Y= 1418 µm
Pixel: X size: 92, Y Size: 128



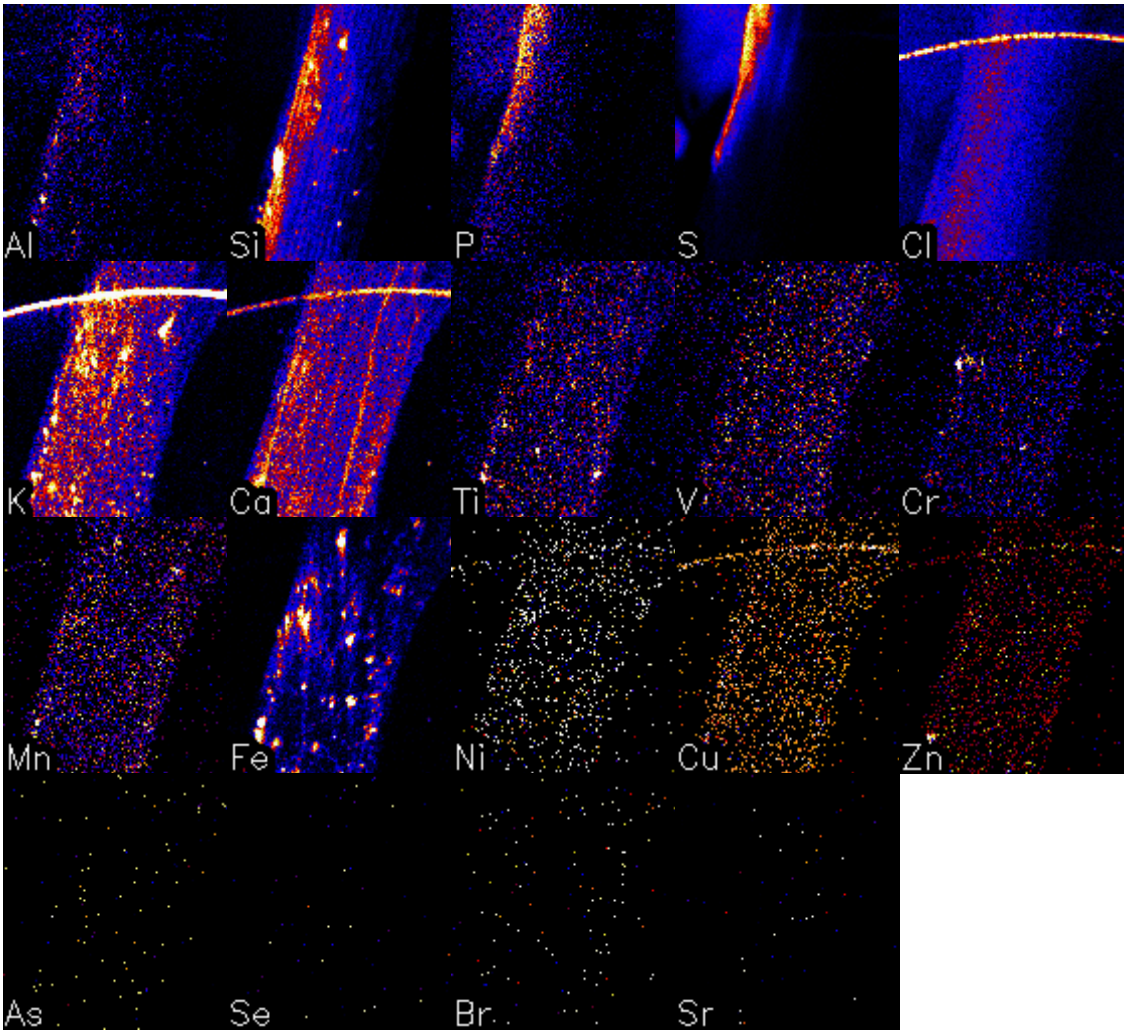
Relative Concentration Legend

Zero Maximum

Fig 3.5.56: WW14 (3) R1 Long root – West Wits (North West) high Au +Ur Reg 0 -2 REM8 (zamx_w295_60-regions-PIXE). Ca, Cr, Fe, K, Mn, P, Ti, Si and S, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Al, Cl, and, Zn, appear to be spread across the root cross-section.

51. WW14 (3) R1 Long root – West Wits (North West) high Au +Ur Reg 0 -4 REM9 (zamx_w295_61-regions-PIXE).

File Name: zamx_w295_61.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1907 µC
Scan: X= 516 µm, Y= 583 µm
Pixel: X size: 112, Y Size: 128



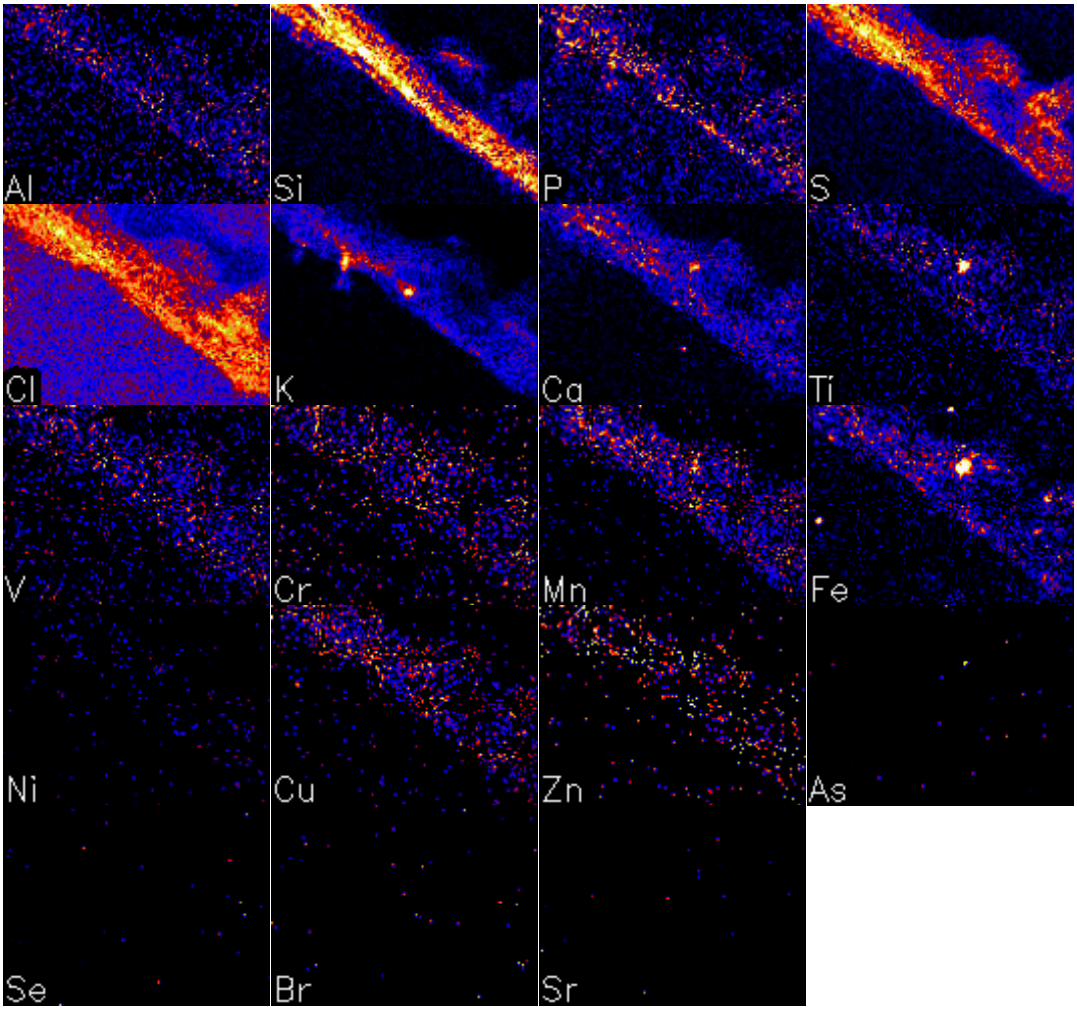
Relative Concentration Legend

Zero  Maximum

Fig 3.5.57: WW14 (3) R1 Long root – West Wits (North West) high Au +Ur Reg 0 -4 REM9 (zamx_w295_61-regions-PIXE). Al, Ca, Cr, Fe, K, Mn, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, P, S, Cu and, Zn, appear to be spread across the root cross-section.

52. Ctr + Nu R2 (6) Long Root Reg 0 -2 Rem 10 (zamx_w295_62-regions-PIXE)

File Name: zamx_w295_62.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1199 µC
Scan: X= 500 µm, Y= 376 µm
Pixel: X size: 128, Y Size: 96



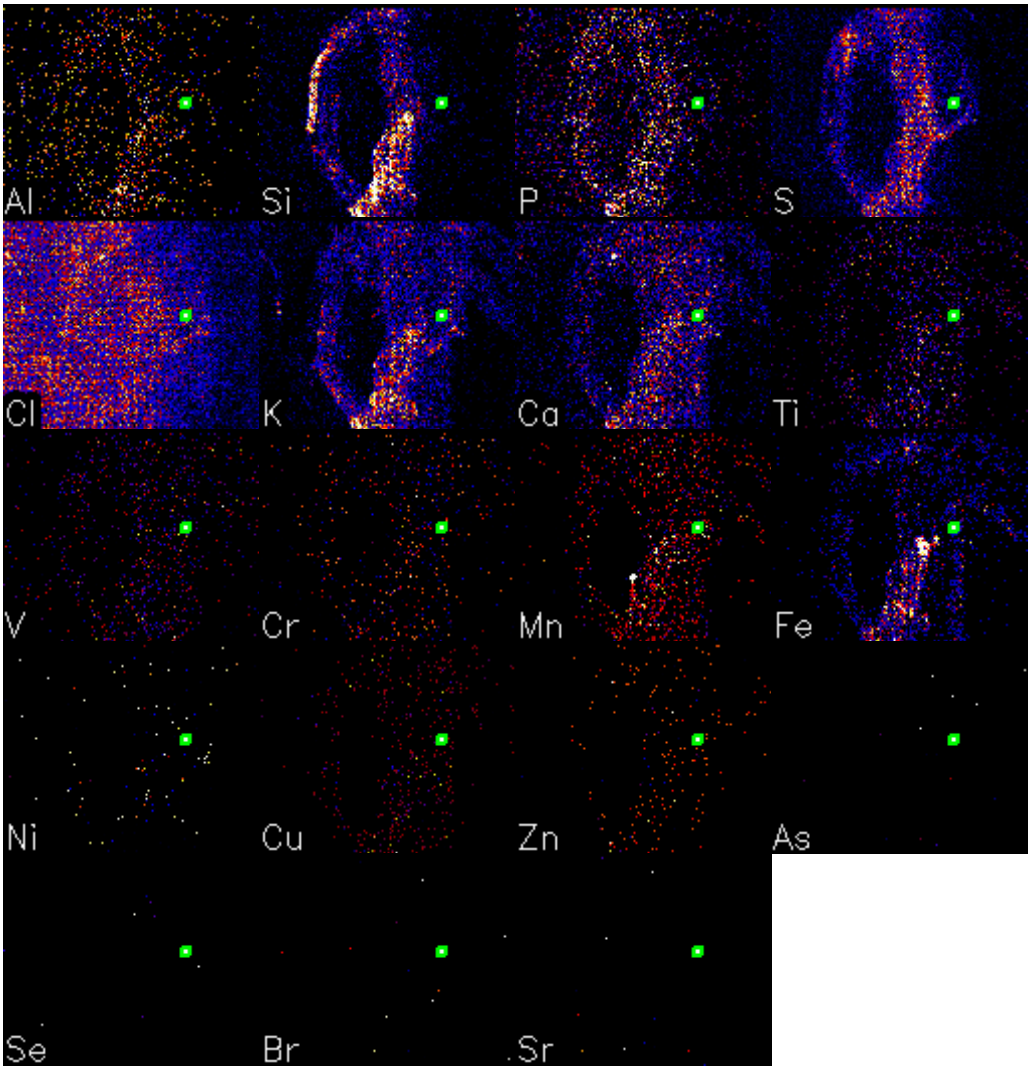
Relative Concentration Legend



Fig 3.5.58: Ctr + Nu R2 (6) Long Root Reg 0 -2 Rem 10 (zamx_w295_62-regions-PIXE). Ca, Cr, Fe, K, Mn, Ti, and were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While Cl, P, S, Cu, Si and, Zn, appear to be spread across the root cross-section.

53. Ctr + Nu R2 (6) Long Root Reg 0 -1 Rem 11 (zamx_w295_63-regions-PIXE) Stopped.

File Name: zamx_w295_63.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 221 µC
Scan: X= 918 µm, Y= 746 µm
Pixel: X size: 128, Y Size: 106



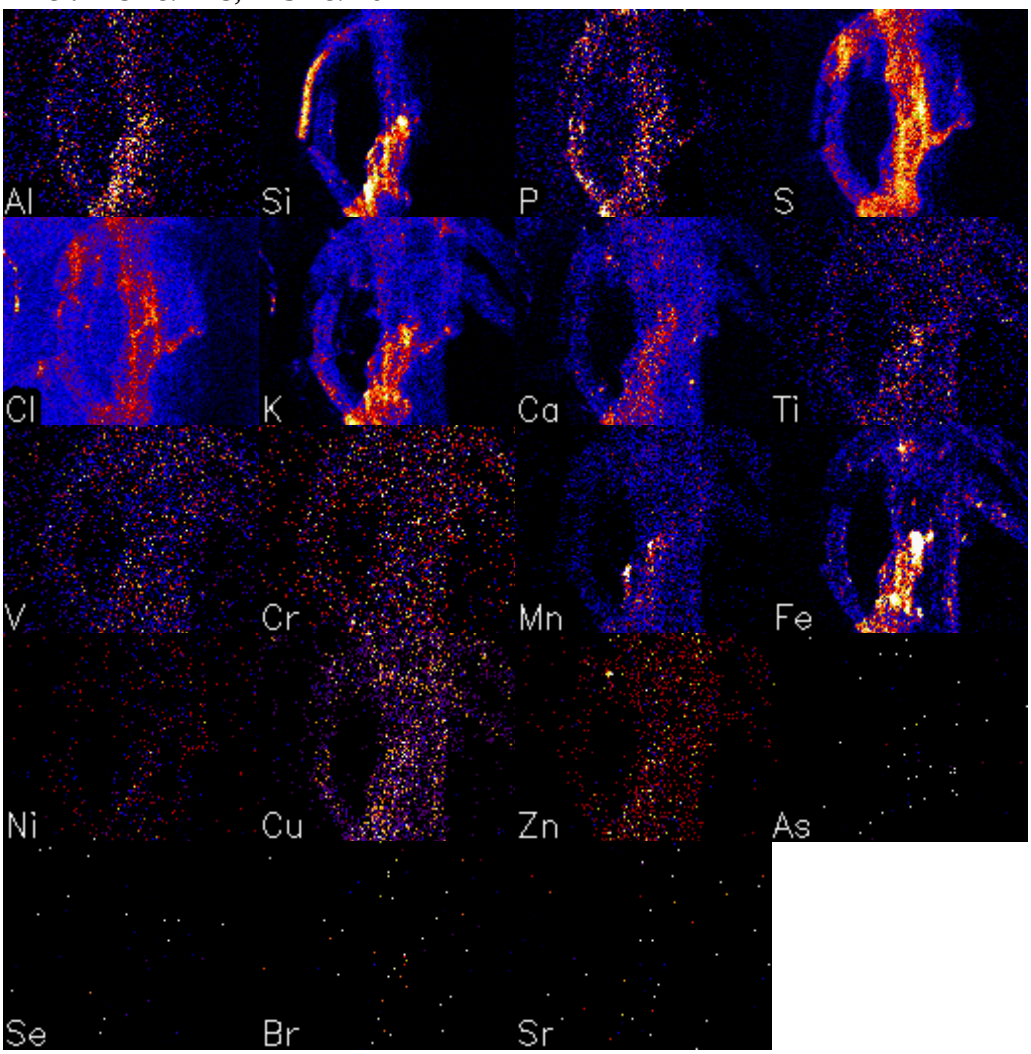
Relative Concentration Legend

Zero  Maximum

Fig 3.5.59: Ctr + Nu R2 (6) Long Root Reg 0 -1 Rem 11 (zamx_w295_63-regions-PIXE) Stopped. Fe, K, Mn, Si, and Ti were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Al, Ca, Cl, P, S, Cu, and, Zn, appear to be spread across the root cross-section.

54. Ctr + Nu R2 (6) Long Root Reg 0 -3 Rem 11 (zamx_w295_64-regions-PIXE) Repeat.

File Name: zamx_w295_64.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1572 µC
Scan: X= 918 µm, Y= 746 µm
Pixel: X size: 128, Y Size: 104



Relative Concentration Legend

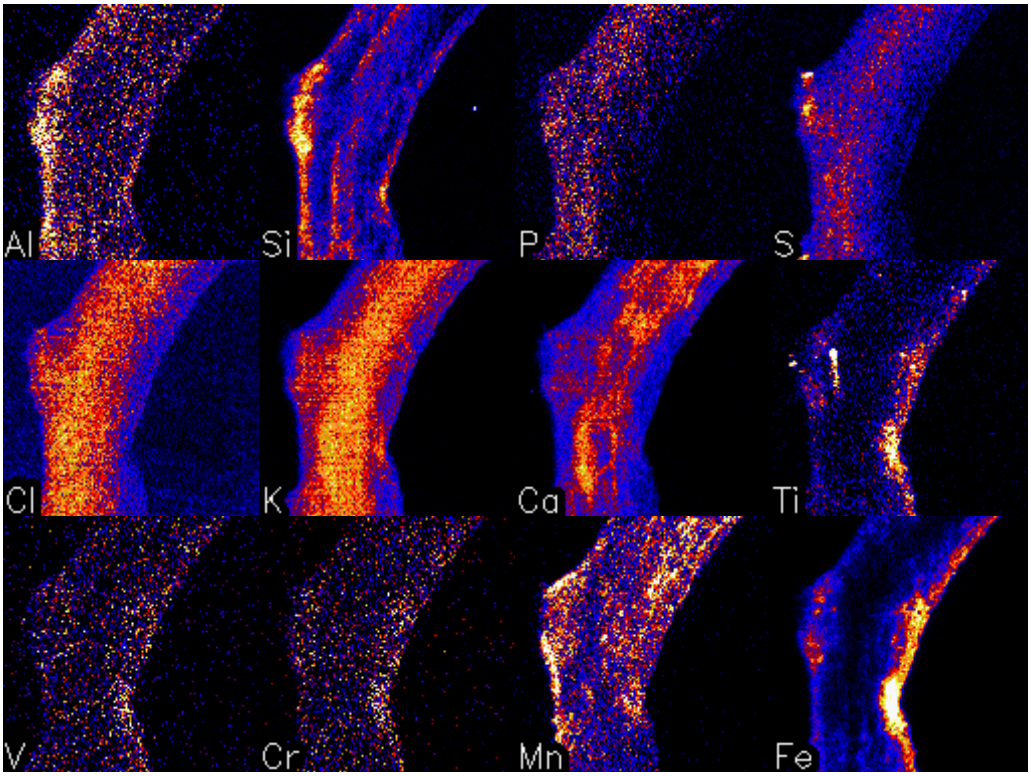
Zero  Maximum

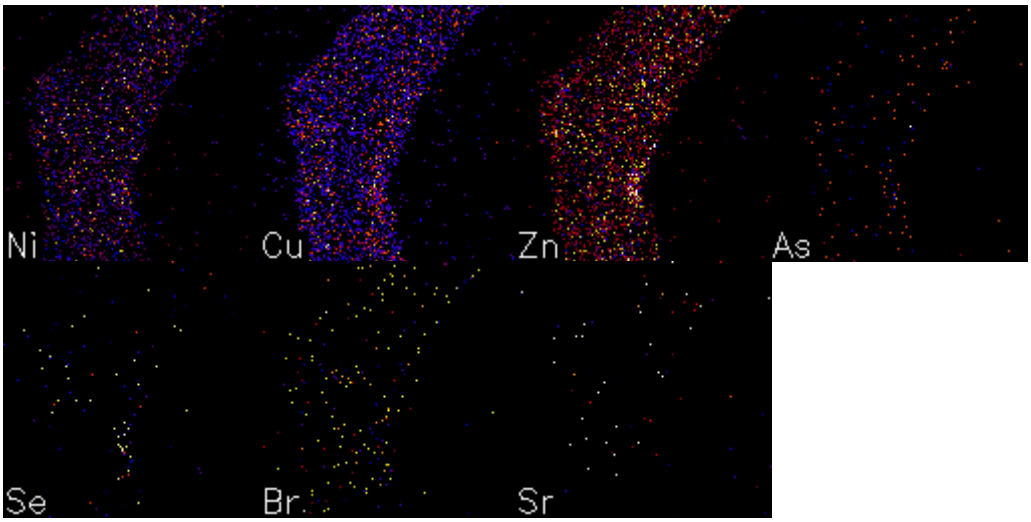
Fig 3.5.60: Ctr + Nu R2 (6) Long Root Reg 0 -3 Rem 11 (zamx_w295_64-regions-PIXE)

Repeat. Fe, Si, K, Mn, and Ti, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Al, Ca, Cl, P, S, Cu and Zn, appear to be spread across the root cross-section.

55. 4.1ER R2 (6) Reg 0 -2 Rem 12 (zamx_w295_65-regions-PIXE)

File Name: zamx_w295_65.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 2195 µC
Scan: X= 584 µm, Y= 583 µm
Pixel: X size: 128, Y Size: 128





Relative Concentration Legend

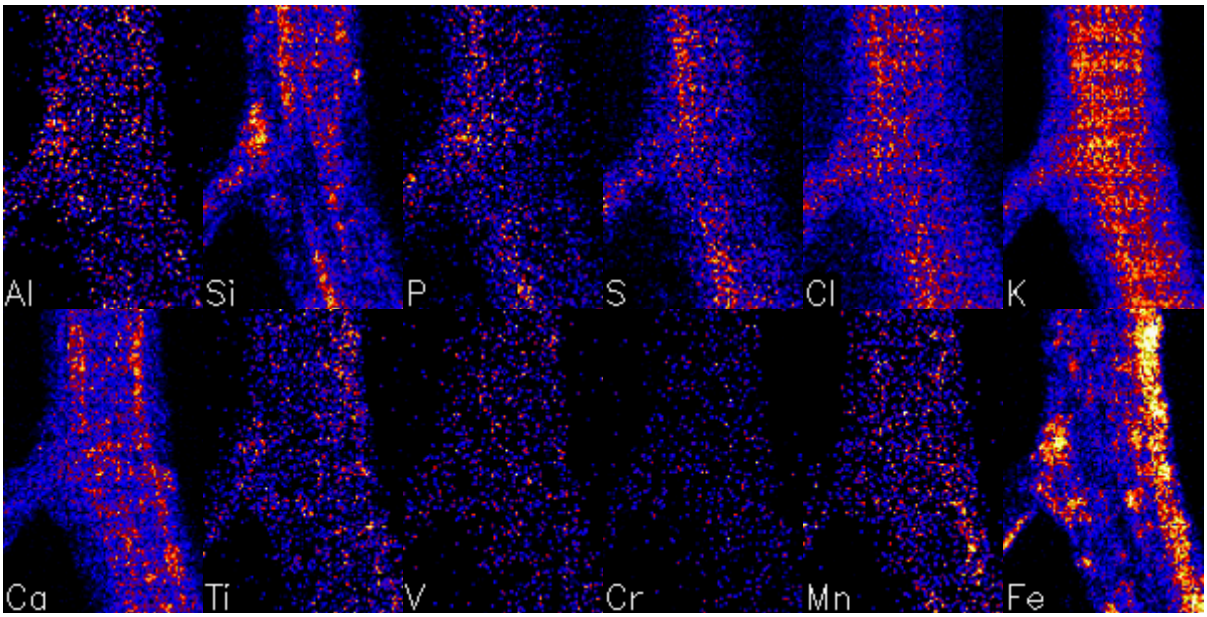
Zero Maximum

Fig 3.5.61: 4.1 ER R2 (6) Reg 0 -2 Rem 12 (zamx_w295_65-regions-PIXE)

Al, Fe, Mn, S, Si and Ti, were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Ca, Cl, P, K, Cu and, Zn, appear to be spread across the root cross-section.

56. 4.1 ER R2 (6) Reg 0 -1 Rem 13 (zamx_w295_66-regions-PIXE)

File Name: zamx_w295_66.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 235 µC
Scan: X= 336 µm, Y= 501 µm
Pixel: X size: 84 Y Size: 128



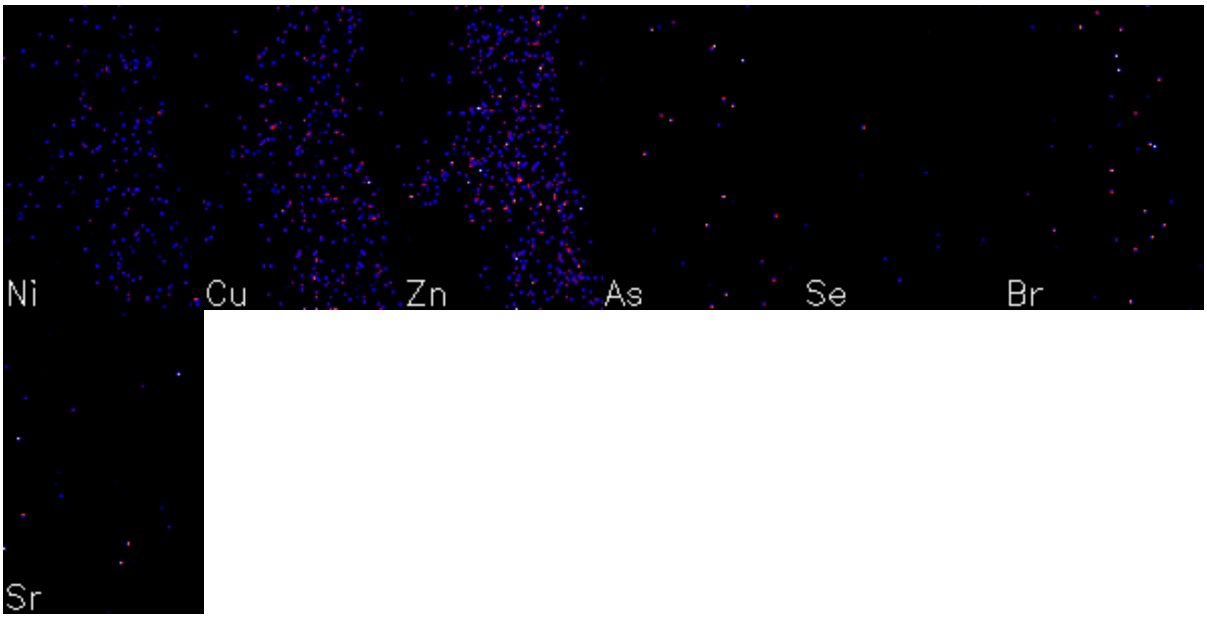


Fig 3.5.62: 4.1 ER R2 (6) Reg 0 -1 Rem 13 (zamx_w295_66-regions-PIXE) (*Beam went down- Q=235nC).* Fe, Mn, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Al, Ca, Cl, P, S, Ti and, K, appear to be spread across the root cross-section.

57. ER R2 (6) Reg 0 -2 Rem 13 (zamx_w295_67-regions-PIXE) (Repeat Q=1856nC).

File Name: zamx_w295_67.evt
Dynamic Matrix: zamx_w295_19.dam
Charge: 1856 µC
Scan: X= 336 µm, Y= 501 µm
Pixel: X size: 84 Y Size: 128

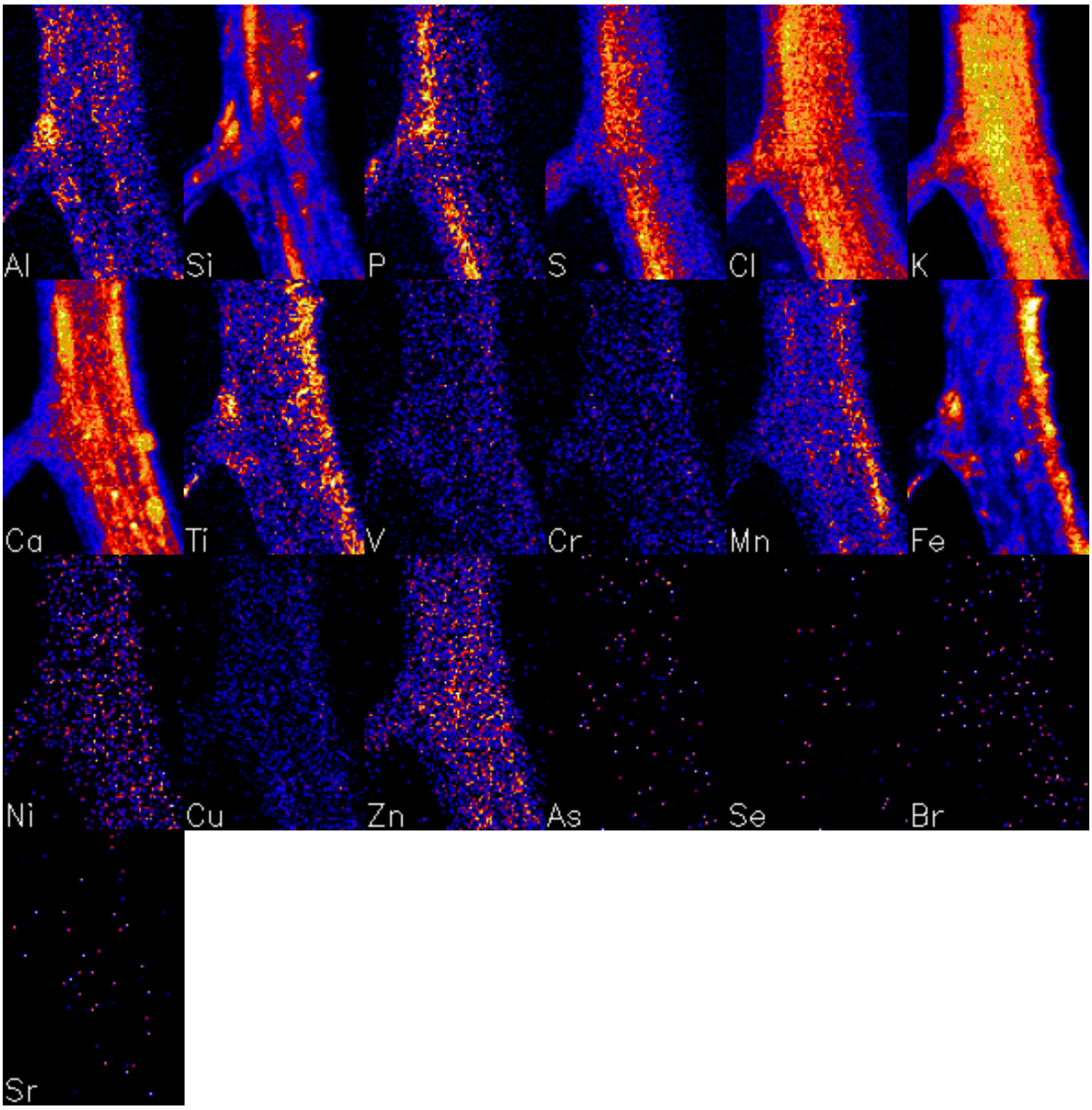
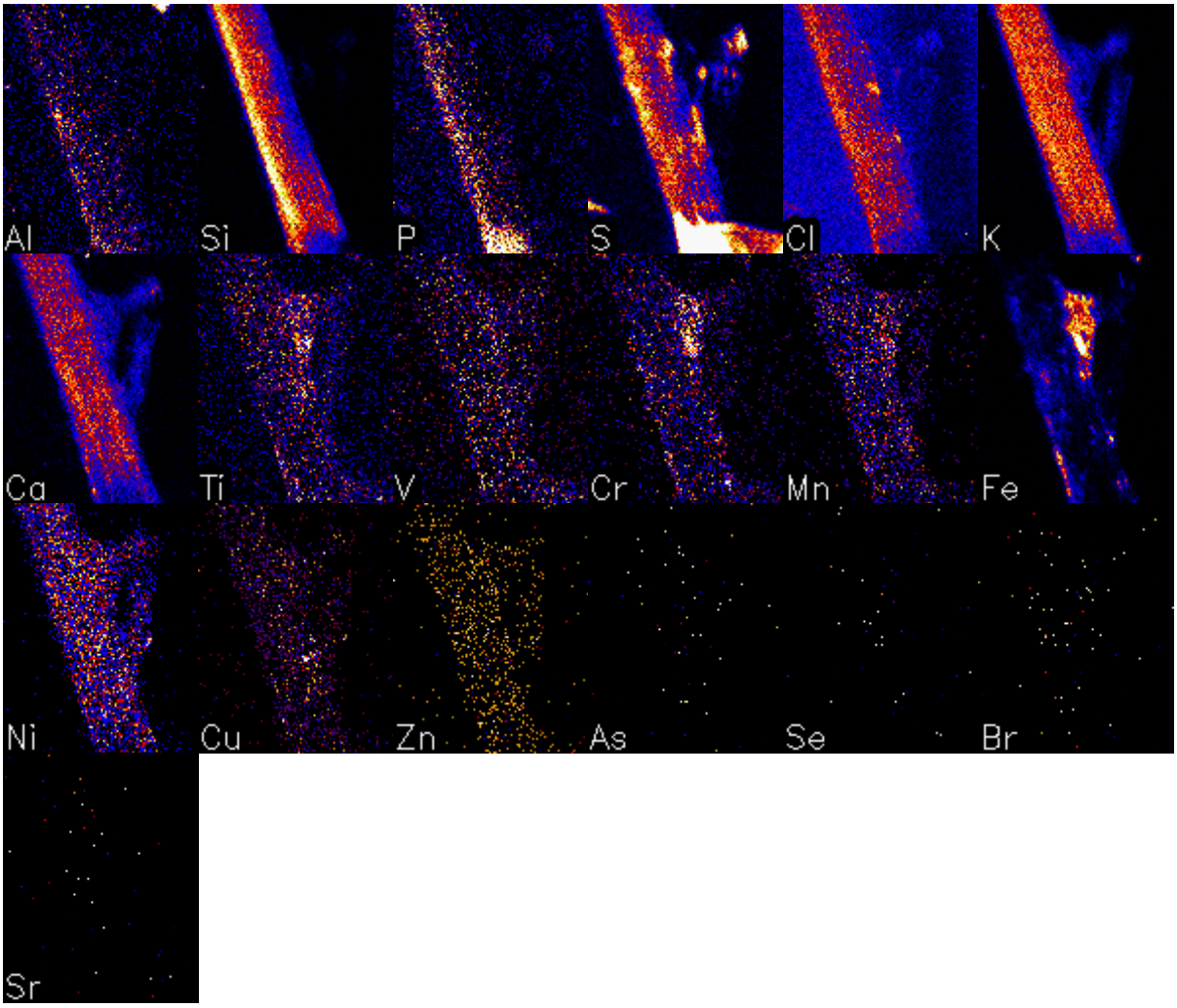


Fig 3.5.63: 4.1 ER R2 (6) Reg 0 -2 Rem 13 (zamx_w295_67-regions-PIXE) (*Repeat Q=1856nC).* Al, Ca, Fe, Mn, Ti, and Si were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Cl, S, P, Zn and, K, appear to be spread across the root cross-section.

58. Gautengg Agnes Mine ABB5 R1(8) B Rem 14 (zamx_w295_68-regions-PIXE).

File Name: zamx_w295_68.evt

Dynamic Matrix: zamx_w295_19.dam
Charge: 1852 µC
Scan: X= 532 µm, Y= 667 µm
Pixel: X size: 100, Y Size: 128



Relative Concentration Legend

Zero  Maximum

Fig 3.5.64: Agnes Mine ABB5 R1(8) B Rem 14 (zamx_w295_68-regions-PIXE). Cr, Cu, Fe, Ti, and S were localized in AMF roots with low concentration and they appear to be accumulated in vesicles and Hyphae. While, Al, Ca, Cl, Mn, Ni, P, Zn, Si and, K, appear to be spread across the root cross-section.