

Preface to Appendices

Eleven separate appendices were developed to capture more of the images and information obtained for Test #2. Several appendices are further divided into subappendices to better segregate the information according to the time point in the test when the samples were extracted from the test apparatus, the type of samples being evaluated, or the type of examinations performed.

Section 3.3 of this report reviewed the nomenclature adopted for reporting ICET results. This nomenclature is used in the caption labels for most of the figures presented in the appendices.

As noted in Section 3.3, the data presented in the appendices are largely qualitative in nature, consisting primarily of ESEM, SEM, and TEM micrographs and EDS spectra. Each appendix represents a separate session of laboratory work that can be traced to a batch of samples that were typically processed in chronological order.

Transcriptions of the logbooks are provided for each appendix to better document commonalities that existed among the samples at the time of analysis. Logbook information was developed for most, but not all, of the images presented in the appendices. Interpretation and understanding of the images and their accompanying EDS spectra can be improved by referring frequently to the logbook sample descriptions and sequences.

Typically, a relatively large quantity of a test sample was delivered for SEM or TEM analysis, and then several small subsamples of each item were examined. Note that each subsample was assigned a sequential reference number during the laboratory session. These reference numbers have been cited in the figure captions whenever possible to preserve the connection between the micrographs and the notebook descriptions. Electronic file names have also been stamped on the images to permit retrieval of the original data files, which are archived elsewhere. Individual data sets for a given sample item have been collated into a typical sequence of (1) visual image, (2) EDS spectra, and (3) semiquantitative mass composition.

Semiquantitative mass compositions are also presented for most of the EDS spectra. These results are obtained from a commercial algorithm that decomposes the spectra into the separate contributions of each element.

The appendices are listed below.

Appendix A SEM/EDS Data for Test #2, Day-15 High-Volume Filter

Appendix B SEM/EDS Data for Test #2, Day-30 Corrosion Products

Appendix C1 SEM/EDS Data for Unused and Test #2, Day-30 Aluminum Coupons

- Appendix C2 SEM/EDS Data for Unused and Test #2, Day-30 Copper Coupons
- Appendix C3 SEM/EDS Data for Unused and Test #2, Day-30 Galvanized Steel Coupons
- Appendix C4 SEM/EDS Data for Unused and Test #2, Day-30 Steel Coupons
- Appendix D1 ESEM and SEM/EDS Data for Test #2, Day-16 Fiberglass in High- and Low-Flow Zones
- Appendix D2 ESEM and SEM/EDS Data for Test #2, Day-30 Fiberglass in High- and Low-Flow Zones
- Appendix D3 ESEM and SEM/EDS Data for Test #2, Day-30 Drain Collar Fiberglass
- Appendix D4 ESEM and SEM/EDS Data for Test #2, Day-30 Birdcage Fiberglass
- Appendix E SEM/EDS Data for T2D30 Sediment
- Appendix F1 TEM Data for Test #2, Day-4 Solution Samples
- Appendix F2 TEM Data for Test #2, Day-17 Solution Samples
- Appendix F3 TEM Data for Test #2, Day-30 Solution Samples
- Appendix G Test #2, Total Organic Carbon (TOC) Concentration
- Appendix H Ultraviolet (UV) Absorbance Spectrum—Day-30 Solution Sample
- Appendix I XRD and XRF Data for Test #2, Day-30 Sediment and Fiberglass in Birdcage
- Appendix J ESEM and SEM/EDS Data for Test #2, Day-4 Filtrate and Fiberglass Samples
- Appendix K ICET Test #2, Pre-Test, Test, and Post-Test Project Instructions

Appendix A

SEM/EDS Data for Test #2, Day-15 High-Volume Filter

Figures

- Figure A-1. SEM image at 120× magnification for a Test #2, Day-15 sample of particles on the high-volume filter. (T2D15_HiVol027) A-4
- Figure A-2. Backscatter SEM image at 800× magnification for a Test #2, Day-15 sample of particles on a high-volume filter. (T2D15_HiVol028)..... A-4
- Figure A-3. EDS counting spectrum for the darker filtrate material shown in Figure A-2, indicating that the dark material is rich in calcium and phosphorus. (T2D15EDS1~Dark Filter Particle)..... A-5
- Figure A-4. EDS counting spectrum for bright flecks on BSE image shown in Figure A-2, suggesting that they are rich in iron, oxygen, and silicon. (T2D15EDS2-Light Spot on Filter)..... A-7

Tables

- Table A-1. Chemical Composition for T2D15EDS1 A-6
- Table A-2. Chemical Composition for T2D15EDS2..... A-8

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During ICET Test #2, work was continued for the purpose of identifying the origin and composition of chemical products that may form in the realistic reactor containment environments that are simulated in the ICET circulation tank. One question of interest is the composition of debris that collects on fiberglass and the composition of particulate substances suspended in the test solution. To partially address this question, a high-volume (1.0-L) filter extracted on Day 15 was examined by SEM/EDS.

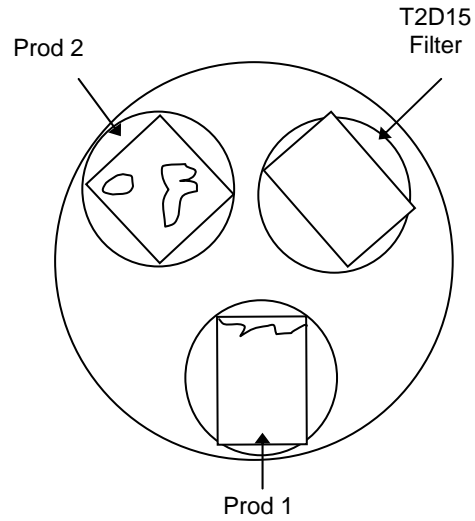
A Test #2, Day-15, high-volume filter sample was extracted from the tank on February 20, 2005. The sample was obtained by filtering 1.0 L of test solution through a 0.7- μm fiberglass filter to retain particulates that were present in the solution. The SEM/EDS data presented here are for the cake layer retained on the filter paper. These examinations were performed on March 7, 2005. Transcribed logbook entries are provided that document the examination sequence and improve the traceability of sample designations.

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Transcribed Laboratory Log

Laboratory session from March 7, 2005

T2D15 Samples—NRC



Conditions: 15-kV, 1-nA beam current, Aperture = 2

Sample T2D15 High-Volume Filter

Image:	T2D15_HiVol027	120 ×	SE image	Figure A-1
	T2D15_HiVol028	800 ×	BSE image	Figure A-2
EDS:	T2D15EDS1		Dark filtrate material	Figure A-3
	T2D15EDS2		Bright flecks on filtrate	Figure A-4

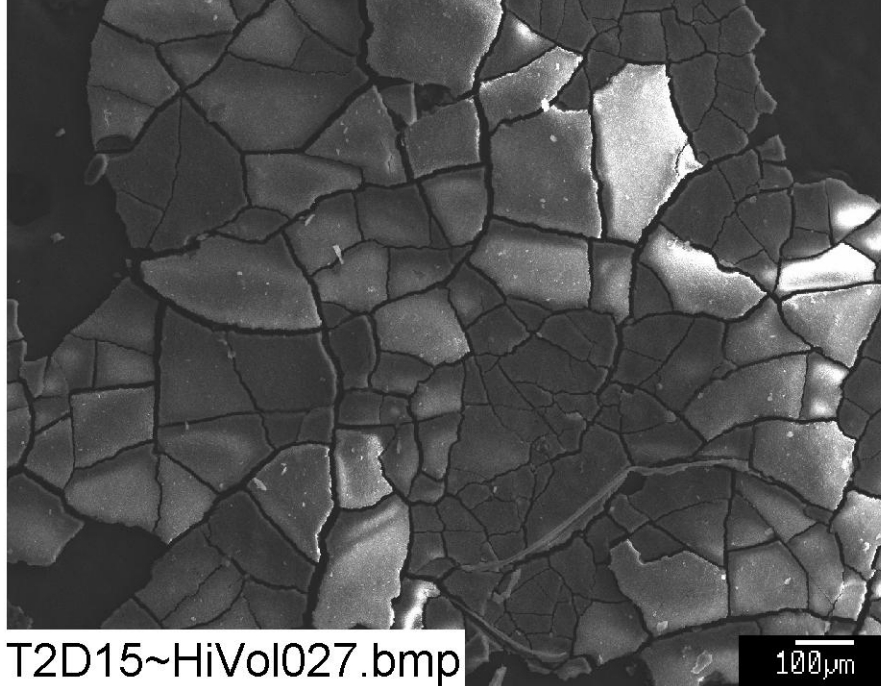


Figure A-1. SEM image at 120 \times magnification for a Test #2, Day-15 sample of particles on the high-volume filter. (T2D15_HiVol027)

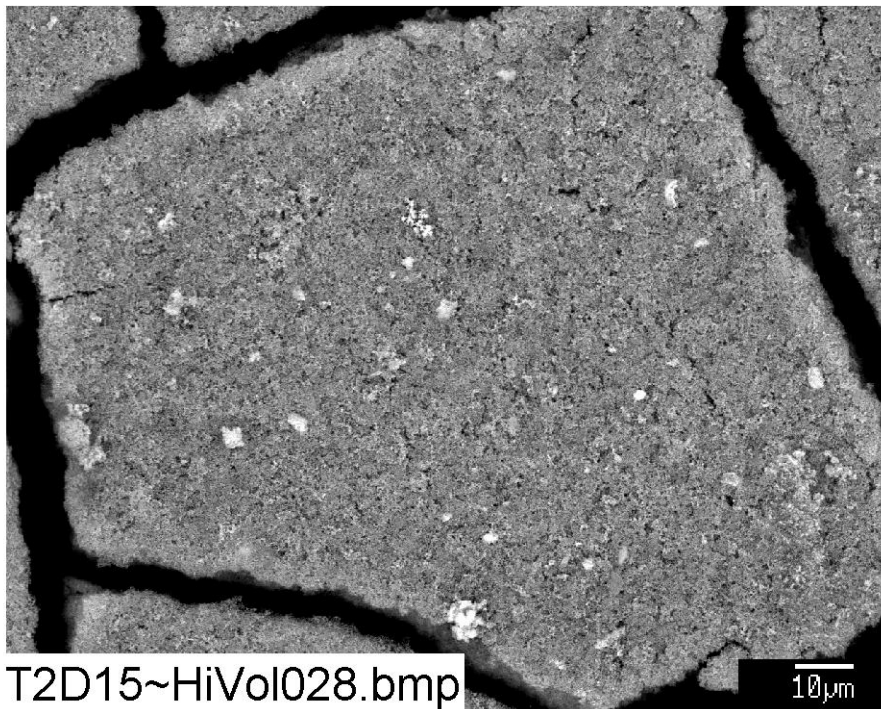


Figure A-2. Backscatter SEM image at 800 \times magnification for a Test #2, Day-15 sample of particles on a high-volume filter. (T2D15_HiVol028)

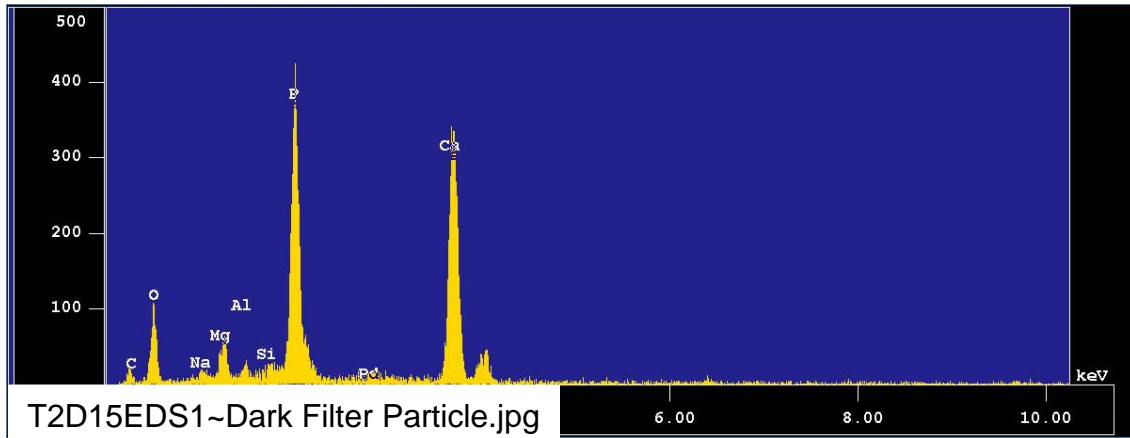


Figure A-3. EDS counting spectrum for the darker filtrate material shown in Figure A-2, indicating that the dark material is rich in calcium and phosphorus. (T2D15EDS1~Dark Filter Particle)

The results from the chemical composition analysis for T2D15EDS1 are given in Table A-1.

Table A-1. Chemical Composition for T2D15EDS1

Mar 7 18:03 2005 /tmp/eds_pout.log Page 1

Group : NRC
 Sample : T2D15 ID# : 1
 Comment : dark filter material
 Condition : Full Scale : 20KeV(10eV/ch,2Kch)
 Live Time : 60.000 sec Aperture # : 1
 Acc. Volt : 20.0 KV Probe Current : 3.145E-10 A
 Stage Point : X=71.012 Y=58.486 Z=10.558
 Acq. Date : Mon Mar 7 18:00:46 2005

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	14.1777	0.0024	857 /	16
Na K	Normal	0.81- 1.27	0.3823	0.0006	89 /	36
Mg K	Normal	0.97- 1.57	1.1233	0.0002	464 /	11
Al K	Normal	1.19- 1.83	0.3982	0.0002	168 /	22
Si K	Normal	1.50- 2.05	0.1620	0.0002	66 /	146
P K	Normal	1.75- 2.38	19.7310	0.0044	4243 /	20
Ca K	Normal	3.39- 4.30	19.8726	0.0022	4688 /	11

 Chi_square = 2.5662

Element	Mass%	Atomic%	ZAF	Z	A	F
O	43.999	62.7558	2.0884	0.9756	2.1406	1.0000
Na	0.929	0.9225	1.6358	1.0261	1.5950	0.9996
Mg	2.960	2.7785	1.7733	0.9692	1.8325	0.9985
Al	0.901	0.7616	1.5219	1.0006	1.5272	0.9960
Si	0.306	0.2489	1.2731	0.9767	1.3168	0.9899
P	21.210	15.6257	0.7234	1.1558	0.6272	0.9978
Ca	29.695	16.9070	1.0055	0.9946	1.0110	1.0000

 Total 100.000 100.0000
 Normalization factor = 1.4860

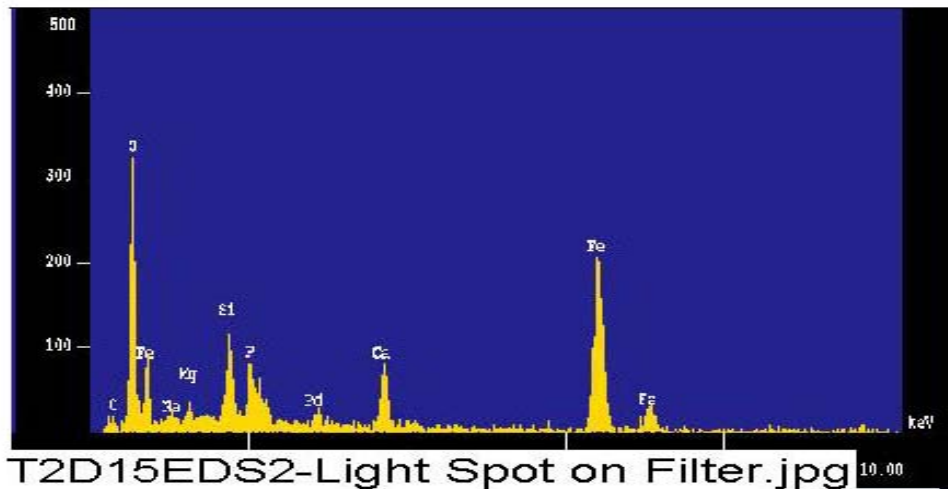


Figure A-4. EDS counting spectrum for bright flecks on BSE image shown in Figure A-2, suggesting that they are rich in iron, oxygen, and silicon. (T2D15EDS2-Light Spot on Filter)

The results from the chemical composition analysis for T2D30EDS2 are given in Table A-2.

Table A-2. Chemical Composition for T2D15EDS2

Mar 7 18:07 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D15 ID# : 2
Comment    : light spot on filter material
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt  : 20.0 KV     Probe Current : 3.100E-10 A
             Stage Point : X=71.012 Y=58.486 Z=10.558
             Acq. Date   : Mon Mar 7 18:05:09 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	53.5124	0.0046	3188 /	16
Si K	Normal	1.50- 2.05	2.7900	0.0003	1114 /	52
Ca K	Normal	3.39- 4.30	4.2434	0.0012	987 /	11
Fe K	Normal	6.00- 7.44	27.6226	0.0029	3385 /	3
P K	Normal	1.75- 2.38	3.2410	0.0025	687 /	66

 Chi_square = 3.3144

Element	Mass%	Atomic%	ZAF	Z	A	F
O	49.185	73.9782	0.7642	0.9424	0.8110	0.9998
Si	5.060	4.3355	1.5079	0.9431	1.6008	0.9989
Ca	4.869	2.9234	0.9540	0.9595	1.0034	0.9909
Fe	37.573	16.1896	1.1309	1.1328	0.9983	1.0000
P	3.312	2.5732	0.8497	1.1159	0.7617	0.9996

 Total 100.000 100.0000
 Normalization factor = 1.2028

Appendix B

SEM/EDS Data for Test #2, Day-30 Corrosion Products

Figures

- Figure B-1. SEM image (150×) for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. (T2D30_Cor_Prod001_Fine Powder)..... B-5
- Figure B-2. SEM image at 1000× magnification for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. (T2D30_Cor_Prod002_Fine Powder) B-5
- Figure B-3. EDS counting spectrum for the SEM image shown in Figure B-2, suggesting that the fine powder may contain magnesium salts [MgCO_3 and/or $\text{Mg}_3(\text{PO}_4)_2$]. (T2D30EDS1-Fine Powder) B-6
- Figure B-4. Another SEM image at 650× magnification for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. The cylinder-shaped debris is likely to be fiberglass. (T2D30_Cor_Prod003_Fine Powder) B-6
- Figure B-5. SEM image (130×) for a Test #2, Day-30 sample of white residue on a horizontal piece of the submerged CPVC rack. (T2D30_Cor_Prod004_White Powder on Rack) B-7
- Figure B-6. EDS counting spectrum collected on the field of view at 130× magnification for the white residue shown in Figure B-5. (T2D30EDS2) B-7
- Figure B-7. Backscattered SEM image at 130× magnification for a Test #2, Day-30 sample of white residue on a horizontal piece of the submerged PVC rack. (T2D30_Cor_Prod005_White Particle on Rack)..... B-9
- Figure B-8. EDS counting spectrum collected on the bright particles shown in Figure B-7. (T2D30EDS3)..... B-9
- Figure B-9. SEM image at 1000× magnification for a Test #2, Day-30 sample of white residue on the horizontal piece of the submerged PVC rack. (T2D30_Cor_Prod006)..... B-11
- Figure B-10. Backscatter SEM overview at 40× magnification of a Test #2, Day-30 sample of white residue on the horizontal piece of the submerged CPVC rack. (Looks similar to the corrosion product on GS). (T2D30_Cor_Prod007_White Particle on Rack)..... B-11

Figure B-11. Backscatter SEM image at 95× magnification of a Test #2, Day-30 sample of corrosion products on a submerged GS coupon. (T2D30_Cor_Prod008_on Galv Steel Submerged)..... B-12

Figure B-12. EDS counting spectrum collected from the center of the SEM image shown in Figure B-11. (T2D30EDS4) B-12

Figure B-13. EDS counting spectrum collected from the upper part of the SEM image shown in Figure B-11. (T2D30EDS5) B-13

Figure B-14. EDS counting spectrum collected from the center of the SEM image shown in Figure B-11 but using a 25-kV beam voltage. (T2D30EDS6) B-15

Figure B-15. EDS counting spectrum for small tubular crystals in Figure B-11, suggesting that the corrosion products of galvanized steel are rich in zinc, phosphorus, and oxygen [possible presence of $Zn_3(PO_4)_2$]...... B-15

Figure B-16. Backscatter SEM image at 120× magnification for a Test #2, Day-30 sample of corrosion products on a submerged GS coupon. (T2D30_Cor_Prod009_on Galv Steel Submerged)..... B-17

Figure B-17. Backscatter SEM image at 55× magnification for a Test #2, Day-30 sample of corrosion products on a submerged GS coupon, annotated to show EDS sample locations. (T2D30_Cor_Prod010_on Galv Steel Submerged) B-17

Figure B-18. EDS counting spectrum collected from the spot EDS9 indicated in Figure B-17. (T2D30EDS9~on Submerged Galv Steel)..... B-18

Figure B-19. EDS counting spectrum collected from the spot EDS10 indicated in Figure B-17. (T2D30EDS10)..... B-18

Figure B-20. Backscatter SEM image at 90× magnification for a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor~Prod011~on Aluminum) B-20

Figure B-21. SEM image at 90× magnification on another area of a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor_Prod012_on Aluminum Submerged) B-20

Figure B-22. EDS counting spectrum for upper right spot in Figure B-21, suggesting that the corrosion products of aluminum are rich in aluminum, silicon, phosphorus, and oxygen. (T2D30EDS11~on Aluminum spot glob)..... B-21

Figure B-23. SEM image at 1000× magnification of a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor_Prod013_on Aluminum Submerged) B-23

Figure B-24. EDS counting spectrum on the center of Figure B-23, suggesting that the corrosion products of aluminum are rich in aluminum, silicon, phosphorus, and oxygen. (T2D30EDS12~on Aluminum Center of Glob)..... B-23

Tables

Table B-1.	The Chemical Composition for T2D30EDS2.....	B-8
Table B-2.	The Chemical Composition for T2D30EDS3.....	B-10
Table B-3.	The Chemical Composition for T2D30EDS5.....	B-14
Table B-4.	The Chemical Composition for T2D30EDS7.....	B-16
Table B-5.	The Chemical Composition for T2D30EDS10.....	B-19
Table B-6.	Chemical Composition for T2D30EDS11.....	B-22
Table B-7.	The Chemical Composition for T2D30EDS12.....	B-24

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For ICET tests, one process of interest is the corrosion effect on metal and concrete coupons. One means of understanding the corrosion process is through direct examination of the corrosion products after the test is completed. For this purpose, corrosion products were collected when Test #2 was shut down (March 7, 2005). These corrosion products included (1) fine powders on a vertical piece of the submerged CPVC rack, (2) white residue on a horizontal piece of the submerged CPVC rack, (3) corrosion products on a submerged GS coupon, and (4) corrosion products on a submerged aluminum coupon.

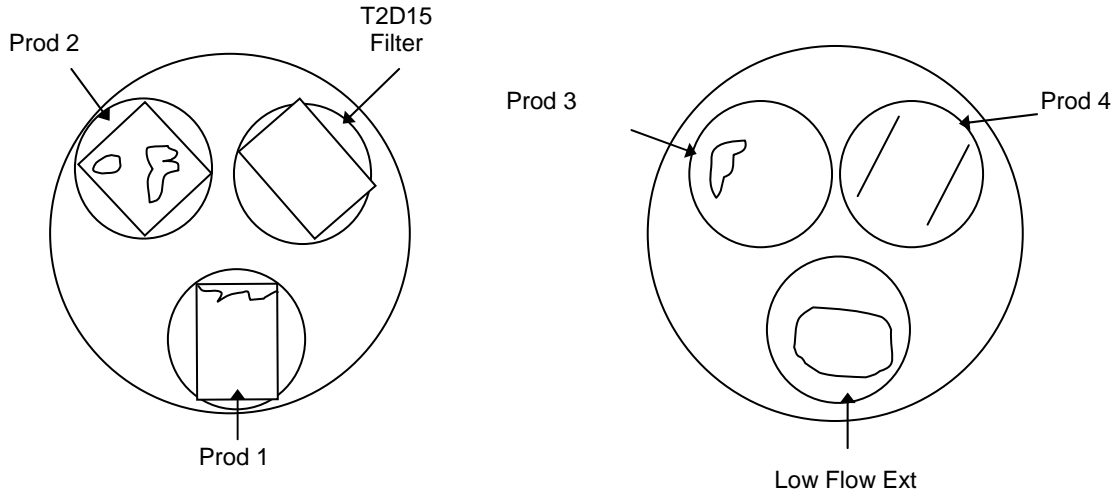
Corrosion products were collected by directly adhering the sample onto double-sided carbon tape suitable for SEM/EDS examination. After the samples were dried in air, a gold/palladium coating was applied to enhance the surface conductivity of the samples and to prevent possible charging problems during the SEM examination. For many samples, semiquantitative elemental analysis was performed on the accompanying EDS spectra. This appendix presents the SEM/EDS data that were generated on March 7, 2005, for each of the sample types identified above. Available logbook entries for this laboratory session are included in this appendix as transcribed notes.

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Transcribed Laboratory Log

Laboratory session from March 7, 2005

T2D30 Samples—NRC



Conditions: 15-kV, 1-nA beam current, Aperture = 2

Product 1. Corrosion Product (Powder) on CPVC

Image:	T2D30_Cor_Prod001	150 ×	SEI	Figure B-1
	T2D30_Cor_Prod002	1000 ×	SEI	Figure B-2
EDS:	T2D30EDS1		EDS of Prod002	Figure B-3
Image	T2D30_Cor_Prod003	650 ×	SEI	Figure B-4

Product 2. Corrosion Product Sediment on Rack

Image:	T2D30_Cor_Prod004	130 ×	SEI	Figure B-5
EDS:	T2D30EDS2		EDS of Prod004	Figure B-6
Image:	T2D30_Cor_Prod005	130 ×	BSE on different area EDS3 collected on bright particle in center right	Figure B-7
EDS:	T2D30EDS3		Bright particle	Figure B-8

Image:	T2D30_Cor_Prod006	1000 ×	SEI	Figure B-9
	T2D30_Cor_Prod007	40 ×	BSE overview	Figure B-10

Product 3. Corrosion Product on Galvanized Steel

Image:	T2D30_Cor_Prod008	95 ×	BSE image	Figure B-11
EDS:	T2D30EDS4		Center of agglomeration in image 008	Figure B-12
	T2D30EDS5		Above location of EDS4	Figure B-13
	T2D30EDS6		Same as EDS4 but using 25 kV	Figure B-14
	T2D30EDS7		Small tubular crystals	Figure B-15
Image:	T2D30_Cor_Prod009	120 ×	BSE of crystal	Figure B-16
	T2D30_Cor_Prod010	55 ×	BSE lower part of sample	Figure B-17
EDS:	T2D30EDS9		Spot on right side of image 010	Figure B-18
	T2D30EDS10		Crystals at left of image 010	Figure B-19

Product 4. Corrosion Product on Aluminum

Image:	T2D30_Cor_Prod011	90 ×	BSE overview	Figure B-20
Image:	T2D30_Cor_Prod012	90 ×	SE image on another area	Figure B-21
EDS:	T2D30EDS11		Spot on agglomeration in upper right of image 012	Figure B-22
	T2D30_Cor_Prod013	1000 ×	SE same area	Figure B-23
EDS:	T2D30EDS12		EDS on center of agglomeration	Figure B-24

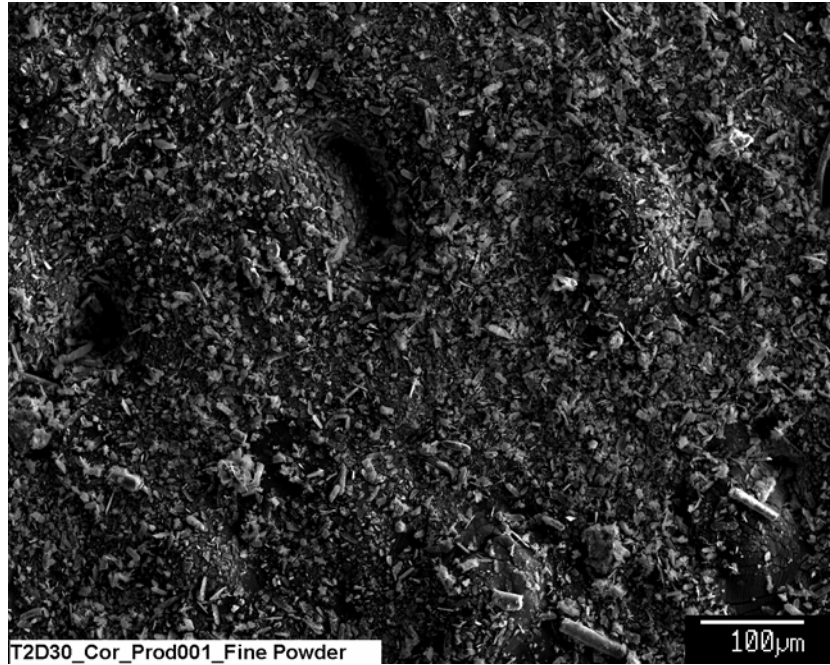


Figure B-1. SEM image (150×) for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. (T2D30_Cor_Prod001_Fine Powder)

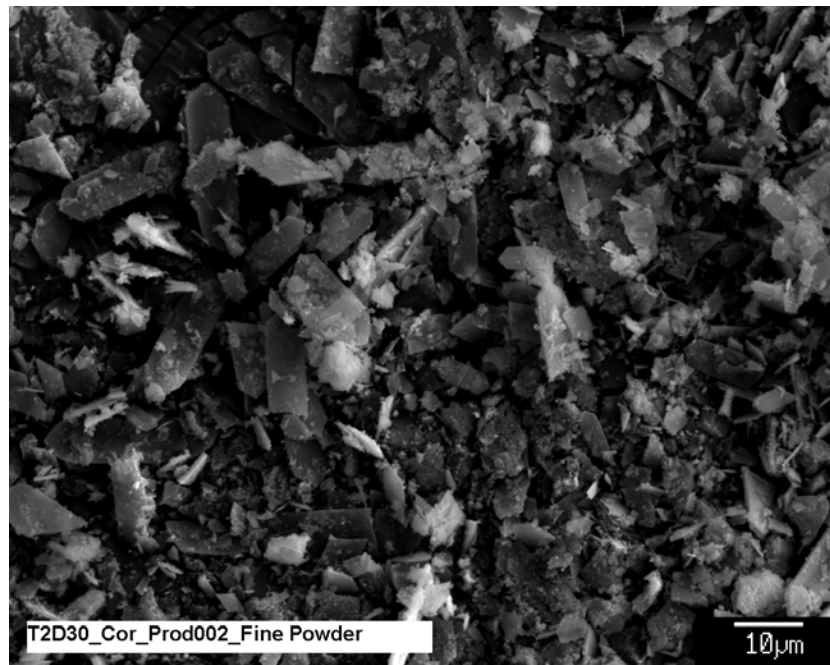


Figure B-2. SEM image at 1000× magnification for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. (T2D30_Cor_Prod002_Fine Powder)

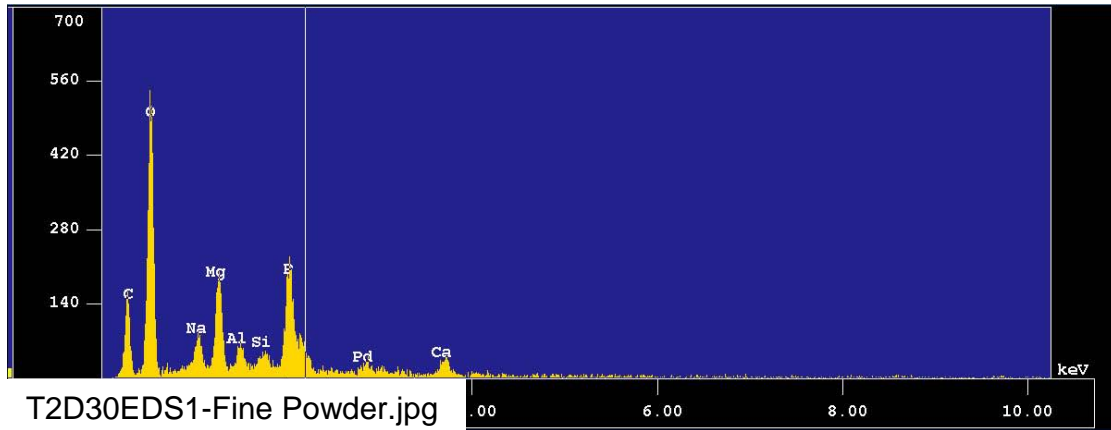


Figure B-3. EDS counting spectrum for the SEM image shown in Figure B-2, suggesting that the fine powder may contain magnesium salts [MgCO_3 and/or $\text{Mg}_3(\text{PO}_4)_2$]. (T2D30EDS1-Fine Powder)



Figure B-4. Another SEM image at 650 \times magnification for a Test #2, Day-30 sample of fine powder on a vertical piece of the submerged PVC rack. The cylinder-shaped debris is likely to be fiberglass. (T2D30_Cor_Prod003_Fine Powder)

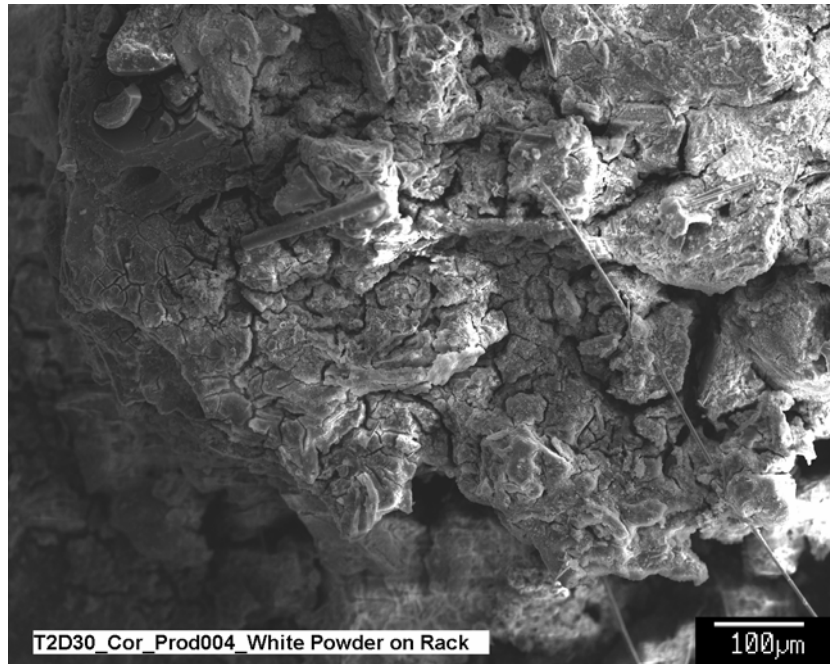


Figure B-5. SEM image (130×) for a Test #2, Day-30 sample of white residue on a horizontal piece of the submerged CPVC rack. (T2D30_Cor_Prod004_White Powder on Rack)

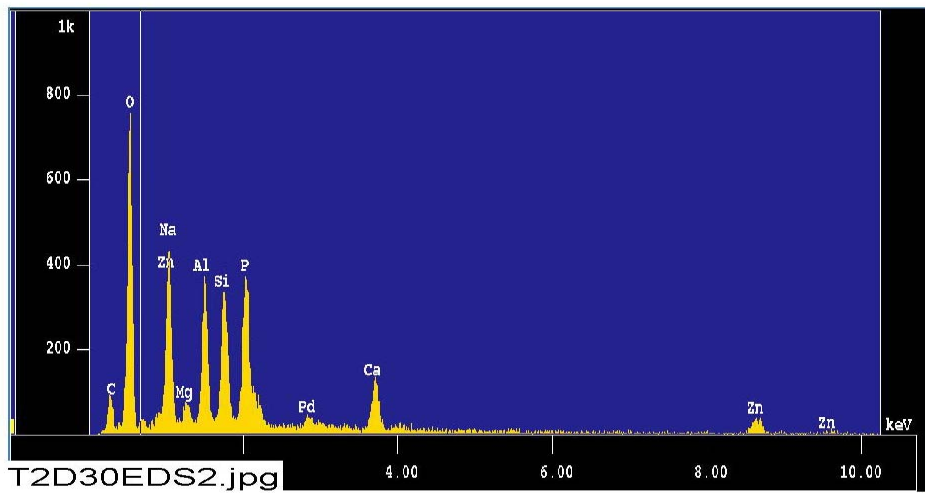


Figure B-6. EDS counting spectrum collected on the field of view at 130× magnification for the white residue shown in Figure B-5. (T2D30EDS2)

The results from the chemical composition analysis for T2D30EDS2 are given in Table B-1.

Table B-1. The Chemical Composition for T2D30EDS2

Mar 7 15:38 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 2
Comment    : Corrosion product sediment on rack
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec Aperture # : 1
             Acc. Volt  : 15.0 KV Probe Current : 1.071E-09 A
             Stage Point : X=83.673 Y=63.044 Z=10.833
             Acq. Date   : Mon Mar 7 15:34:35 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
C K	Normal	0.09- 0.46	0.7465	0.0004	278 / 70
O K	Normal	0.25- 0.77	26.0444	0.0035	6529 / 62
Na K	Normal	0.83- 1.28	0.8606	0.0133	678 / 45
Al K	Normal	1.26- 1.78	2.5000	0.0010	2970 / 157
Si K	Normal	1.50- 2.07	2.5870	0.0014	3072 / 265
Ca K	Normal	3.40- 4.30	2.3973	0.0067	1506 / 10
Fe K	Normal	6.04- 7.40	0.0295	0.0279	6 / 8
Zn K	Normal	8.22-10.03	8.4662	0.0065	613 / 5

Chi_square = 6.9122

Element	Mass%	Atomic%	ZAF	Z	A	F
C	6.592	11.4056	4.4054	1.0018	4.3976	1.0000
O	51.610	67.0354	0.9885	0.9553	1.0347	1.0000
Na	2.469	2.2320	1.4313	0.9592	1.4903	1.0012
Al	6.884	5.3019	1.3736	0.9668	1.4225	0.9988
Si	6.586	4.8732	1.2700	0.9548	1.3302	0.9999
Ca	4.631	2.4012	0.9637	0.9664	0.9977	0.9995
Fe	0.055	0.0205	0.9310	0.9595	1.0014	0.9689
Zn	21.171	6.7302	1.2474	1.2511	0.9971	1.0000

Total 100.000 100.0000
Normalization factor = 2.0047



Figure B-7. Backscattered SEM image at 130× magnification for a Test #2, Day-30 sample of white residue on a horizontal piece of the submerged PVC rack. (T2D30_Cor_Prod005_White Particle on Rack)

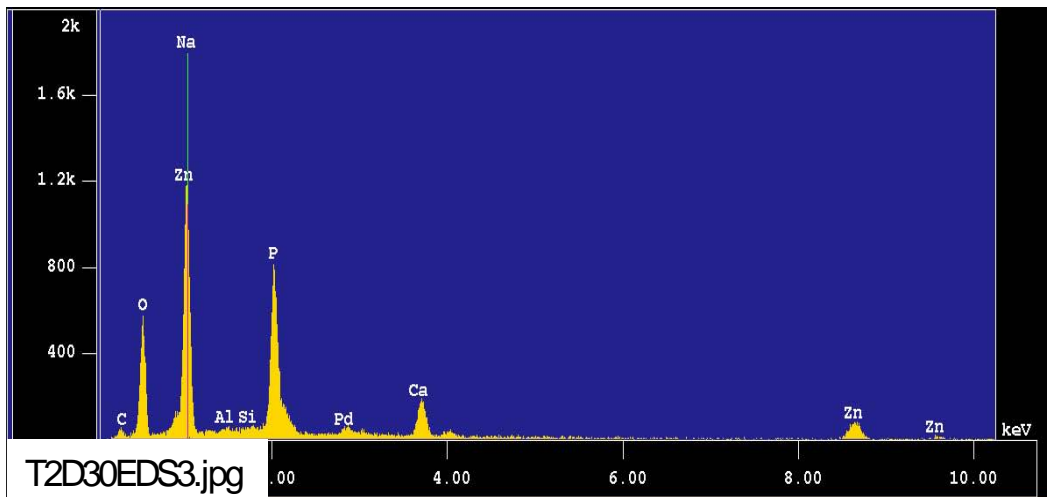


Figure B-8. EDS counting spectrum collected on the bright particles shown in Figure B-7. (T2D30EDS3)

The results from the chemical composition analysis for T2D30EDS2 are given in Table B-2.

Table B-2. The Chemical Composition for T2D30EDS3

Mar 7 15:42 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 3
Comment    : Corrosion product sediment on rack
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt   : 15.0 KV     Probe Current : 1.064E-09 A
             Stage Point : X=83.602 Y=62.915 Z=10.833
             Acq. Date   : Mon Mar 7 15:40:33 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	19.4279	0.0031	4838 /	46
P K	Normal	1.75- 2.38	13.5910	0.0051	8082 /	50
Ca K	Normal	3.40- 4.30	3.5982	0.0082	2245 /	20
Zn K	Normal	8.22-10.03	18.9540	0.0093	1363 /	6

 Chi_square = 4.9345

Element	Mass%	Atomic%	ZAF	Z	A	F
O	35.902	61.6543	1.1175	0.9205	1.2141	1.0000
P	21.205	18.8094	0.9435	1.1063	0.8530	0.9998
Ca	5.687	3.8987	0.9558	0.9266	1.0321	0.9994
Zn	37.206	15.6376	1.1870	1.1878	0.9993	1.0000

 Total 100.000 100.0000
 Normalization factor = 1.6537

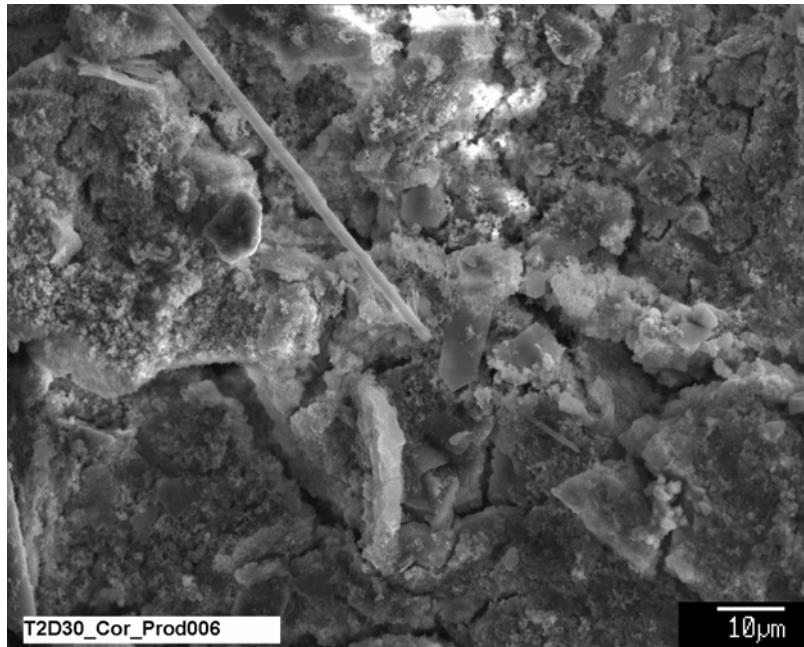


Figure B-9. SEM image at 1000× magnification for a Test #2, Day-30 sample of white residue on the horizontal piece of the submerged PVC rack. (T2D30_Cor_Prod006)

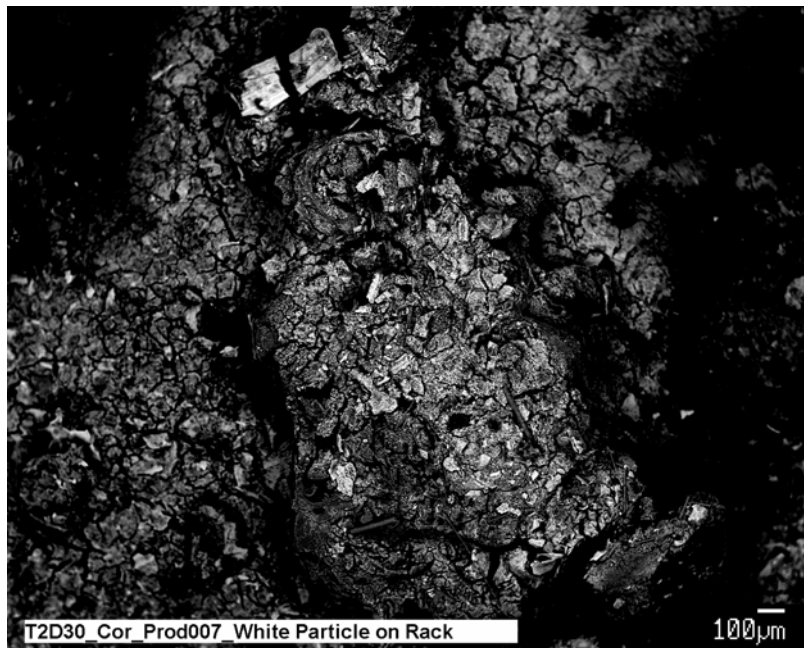


Figure B-10. Backscatter SEM overview at 40× magnification of a Test #2, Day-30 sample of white residue on the horizontal piece of the submerged CPVC rack. (Looks similar to the corrosion product on GS). (T2D30_Cor_Prod007_White Particle on Rack)

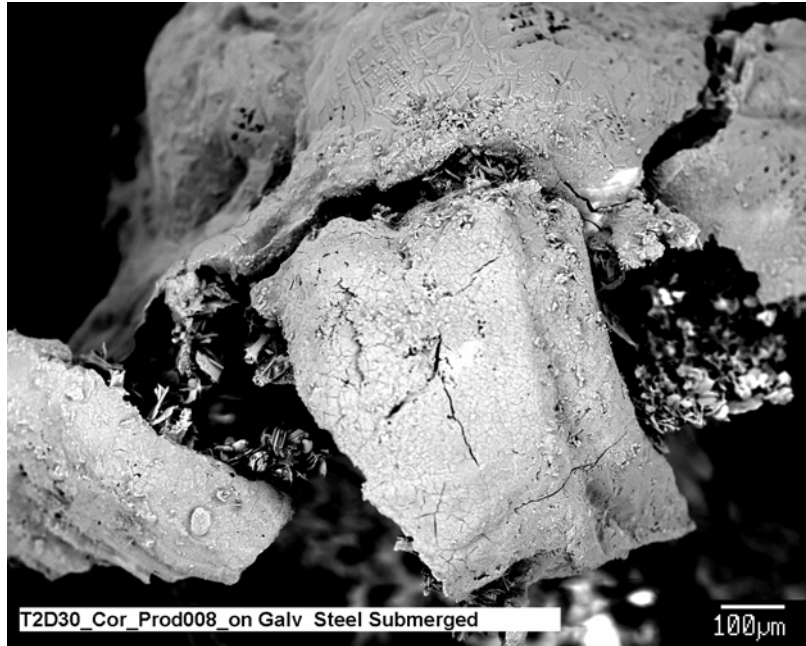


Figure B-11. Backscatter SEM image at 95× magnification of a Test #2, Day-30 sample of corrosion products on a submerged GS coupon. (T2D30_Cor_Prod008_on Galv Steel Submerged)

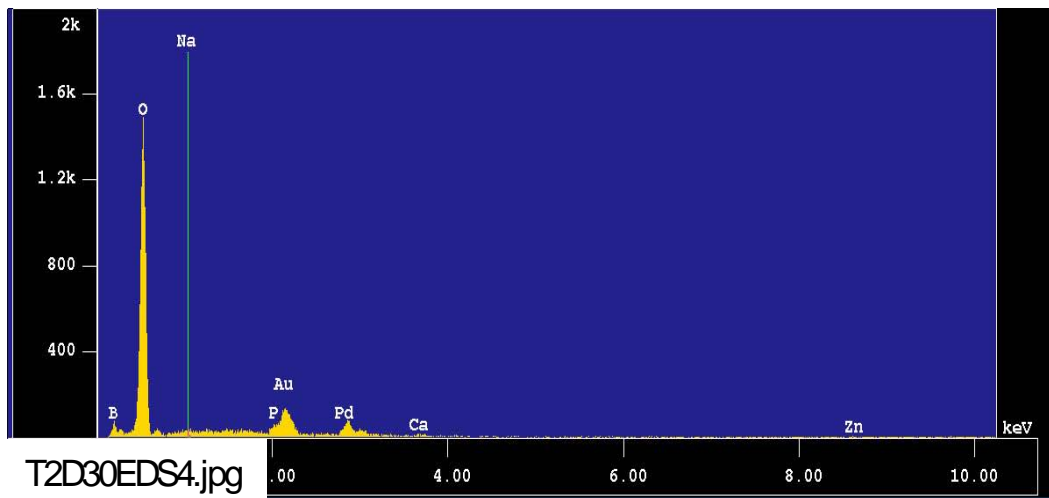


Figure B-12. EDS counting spectrum collected from the center of the SEM image shown in Figure B-11. (T2D30EDS4)

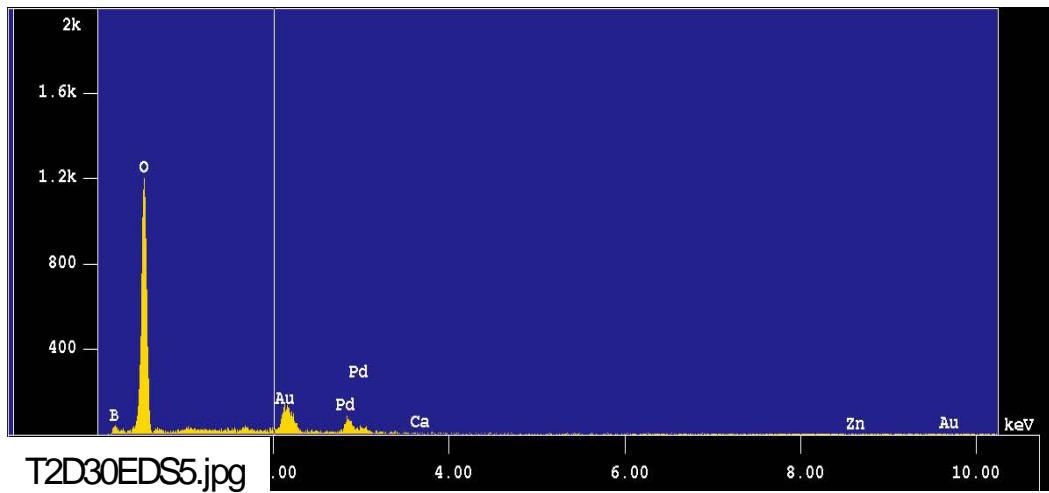


Figure B-13. EDS counting spectrum collected from the upper part of the SEM image shown in Figure B-11. (T2D30EDS5)

The results from the chemical composition analysis for T2D30EDS5 are given in Table B-3.

Table B-3. The Chemical Composition for T2D30EDS5

Mar 7 16:19 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 5
Comment    : Corrosion product on galv steel
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #      : 1
             Acc. Volt   : 15.0 KV      Probe Current   : 1.072E-09 A
             Stage Point : X=20.619 Y=59.144 Z=10.833
             Acq. Date   : Mon Mar 7 15:59:51 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
B K	Normal	0.00- 0.36	1.4897	0.0002	156 / 13
O K	Normal	0.25- 0.77	40.4790	0.0042	10156 / 18
Zn K	Normal	8.22-10.03	0.0000	0.0000	0 / 2

 Chi_square = 72.1961

Element	Mass%	Atomic%	ZAF	Z	A	F
B	20.212	27.2669	4.4701	1.1295	3.9577	1.0000
O	79.788	72.7331	0.6494	0.9731	0.6673	1.0000
Zn	0.000	0.0000	1.2952	1.3038	0.9934	1.0000

 Total 100.000 100.0000
 Normalization factor = 3.0354

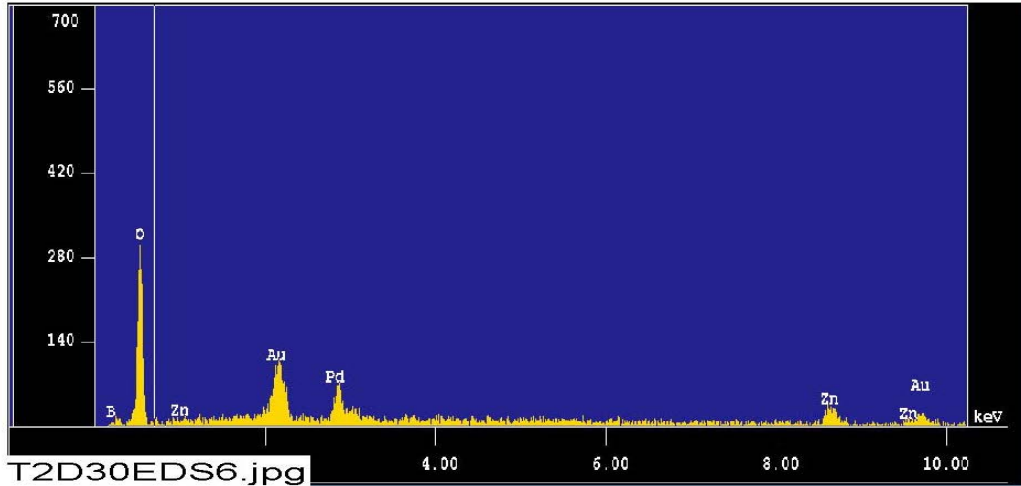


Figure B-14. EDS counting spectrum collected from the center of the SEM image shown in Figure B-11 but using a 25-kV beam voltage. (T2D30EDS6)

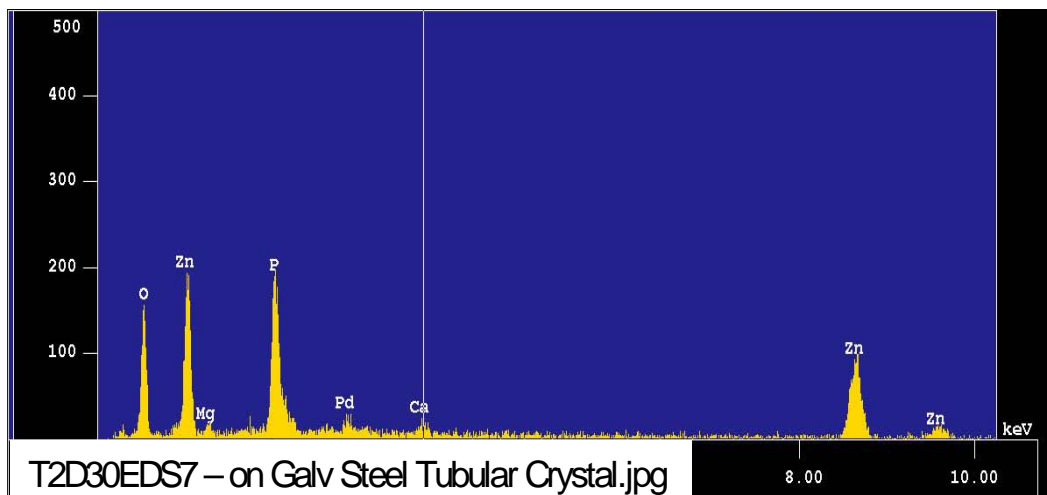


Figure B-15. EDS counting spectrum for small tubular crystals in Figure B-11, suggesting that the corrosion products of galvanized steel are rich in zinc, phosphorus, and oxygen [possible presence of $Zn_3(PO_4)_2$].

The results from the chemical composition analysis for T2D30EDS7 are given in Table B-4.

Table B-4. The Chemical Composition for T2D30EDS7

Mar 7 16:11 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 7
Comment    : corrosion product on galv steel
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt   : 20.0 KV     Probe Current : 3.863E-10 A
             Stage Point : X=20.619 Y=59.144 Z=10.833
             Acq. Date   : Mon Mar 7 16:08:57 2005
    
```

Element	Mode	ROI (KeV)	K-ratio (%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	17.5032	0.0028	1299 /	12
Mg K	Normal	0.97- 1.57	0.2027	0.0002	103 /	50
P K	Normal	1.75- 2.38	7.7861	0.0032	2056 /	10
Zn K	Normal	8.22-10.03	21.2758	0.0050	1615 /	4

 Chi_square = 2.8316

Element	Mass%	Atomic%	ZAF	Z	A	F
O	33.841	61.7575	0.9431	0.9116	1.0346	0.9999
Mg	1.528	1.8349	3.6762	0.9047	4.0654	0.9996
P	15.204	14.3319	0.9525	1.0778	0.8837	1.0001
Zn	49.426	22.0757	1.1331	1.1370	0.9966	1.0000

 Total 100.000 100.0000
 Normalization factor = 2.0502

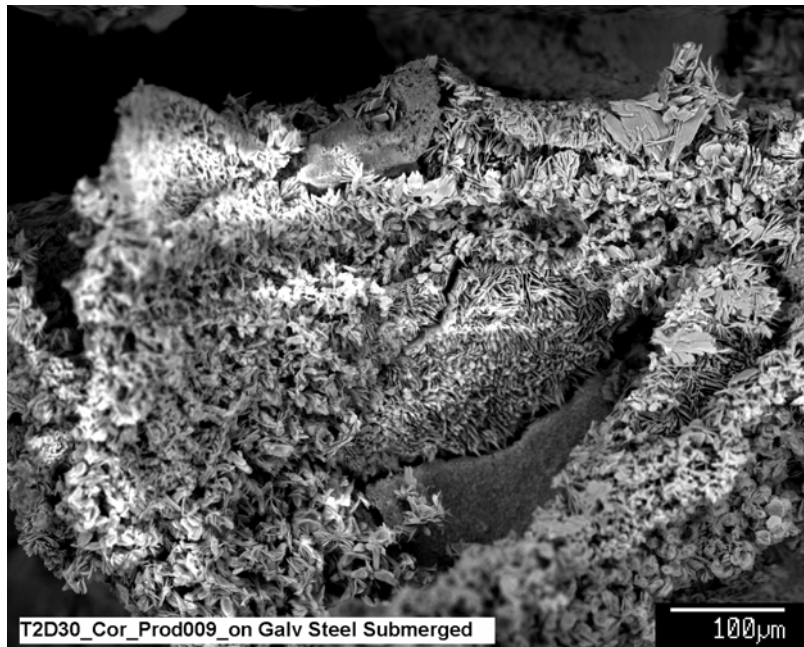


Figure B-16. Backscatter SEM image at 120× magnification for a Test #2, Day-30 sample of corrosion products on a submerged GS coupon. (T2D30_Cor_Prod009_on Galv Steel Submerged)



Figure B-17. Backscatter SEM image at 55× magnification for a Test #2, Day-30 sample of corrosion products on a submerged GS coupon, annotated to show EDS sample locations. (T2D30_Cor_Prod010_on Galv Steel Submerged)

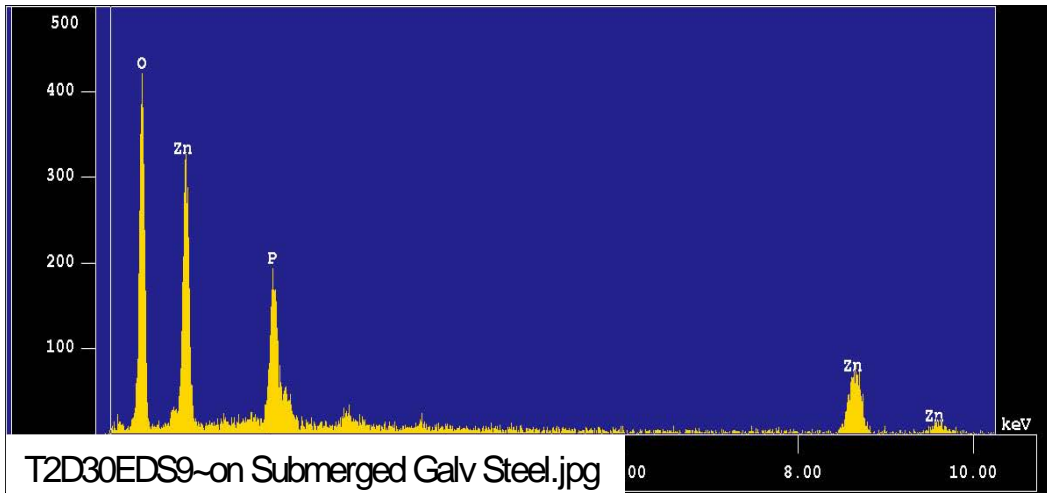


Figure B-18. EDS counting spectrum collected from the spot EDS9 indicated in Figure B-17. (T2D30EDS9~on Submerged Galv Steel)

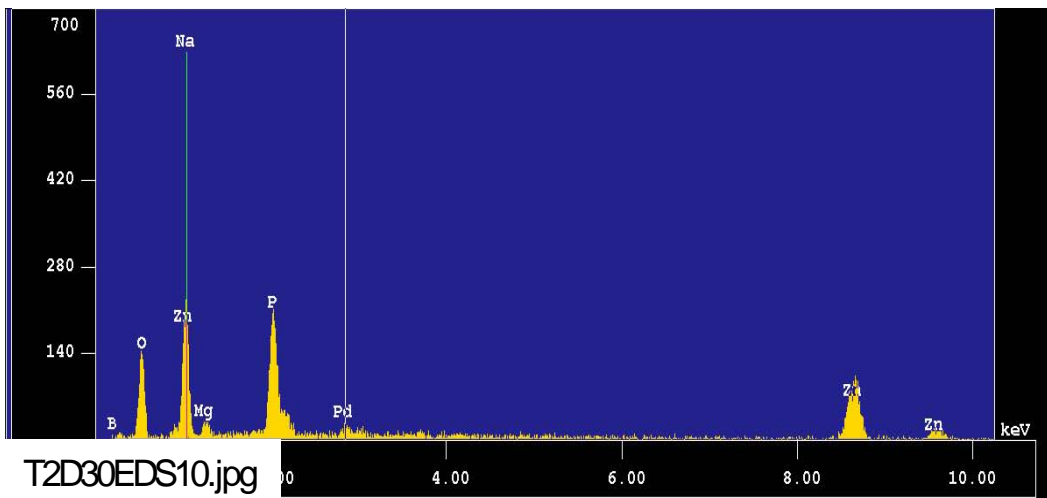


Figure B-19. EDS counting spectrum collected from the spot EDS10 indicated in Figure B-17. (T2D30EDS10)

The results from the chemical composition analysis for T2D30EDS10 are given in Table B-5.

Table B-5. The Chemical Composition for T2D30EDS10

Mar 7 16:34 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 10
Comment    : Corrosion product on galv steel
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt  : 20.0 KV      Probe Current : 3.658E-10 A
             Stage Point: X=20.619 Y=62.110 Z=10.558
             Acq. Date  : Mon Mar 7 16:29:13 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	17.7418	0.0029	1247 /	6
Zn K	Normal	8.22-10.03	24.1289	0.0053	1735 /	3
P K	Normal	1.75- 2.38	8.9417	0.0034	2236 /	12
Na K	Normal	0.81- 1.27	0.0000	0.0000	0 /	16
Mg K	Normal	0.97- 1.57	0.4076	0.0002	196 /	42

Chi_square = 2.3325

Element	Mass%	Atomic%	ZAF	Z	A	F
O	31.348	58.5209	0.9613	0.9101	1.0564	0.9999
Zn	50.152	22.9142	1.1308	1.1343	0.9969	1.0000
P	15.751	15.1883	0.9584	1.0759	0.8907	1.0001
Na	0.000	0.0000	2.6509	0.9564	2.7714	1.0001
Mg	2.749	3.3766	3.6685	0.9031	4.0639	0.9995

Total 100.000 100.0000
Normalization factor = 1.8381

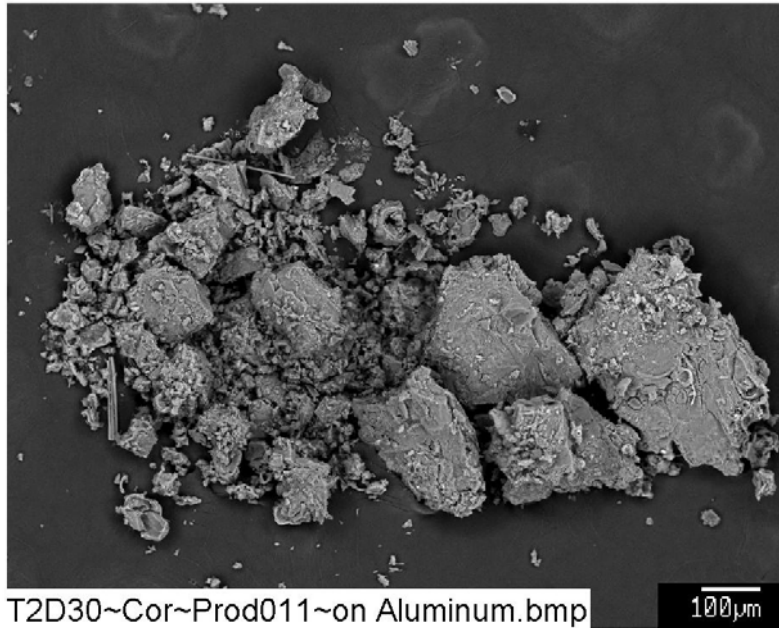


Figure B-20. Backscatter SEM image at 90× magnification for a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor~Prod011~on Aluminum)

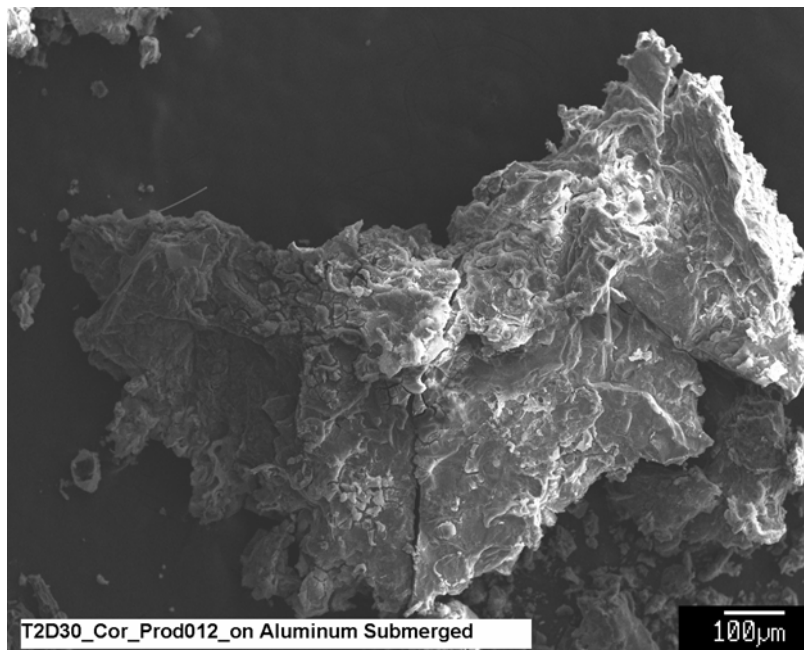


Figure B-21. SEM image at 90× magnification on another area of a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor_Prod012_on Aluminum Submerged)

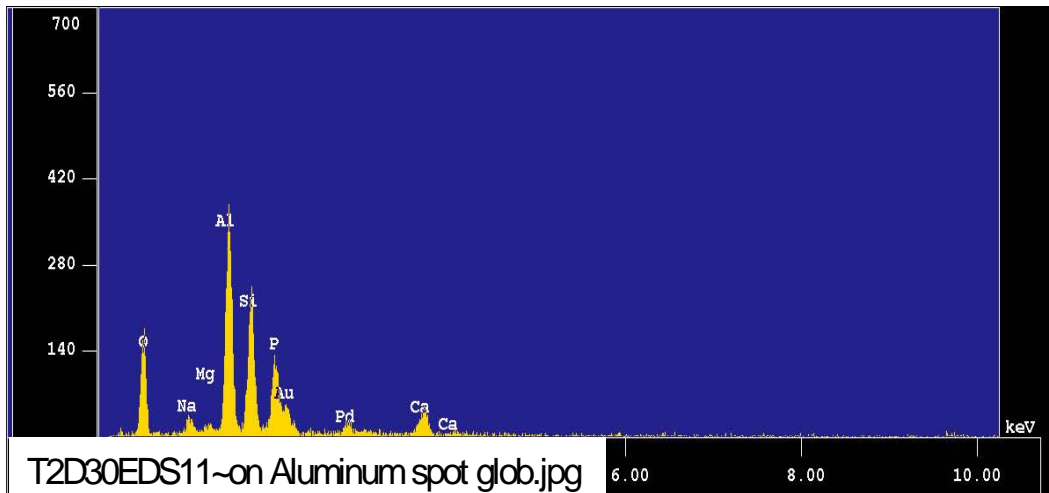


Figure B-22. EDS counting spectrum for upper right spot in Figure B-21, suggesting that the corrosion products of aluminum are rich in aluminum, silicon, phosphorus, and oxygen. (T2D30EDS11~on Aluminum spot glob)

The results from the chemical composition analysis for T2D30EDS11 are given in Table B-6.

Table B-6. Chemical Composition for T2D30EDS11

Mar 7 16:45 2005 /tmp/eds_pout.log Page 1

```

Group       : NRC
Sample      : T2D30 ID# : 11
Comment     : Corrosion product on Aluminum
Condition   : Full Scale : 20KeV(10eV/ch,2Kch)
              Live Time  : 60.000 sec   Aperture #   : 1
              Acc. Volt  : 20.0 KV      Probe Current : 3.506E-10 A
              Stage Point : X= 5.779 Y=60.038 Z=10.558
              Acq. Date  : Mon Mar 7 16:43:34 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
O K	Normal	0.25- 0.77	21.1440	0.0030	1425 / 6
Na K	Normal	0.81- 1.27	0.9134	0.0007	238 / 12
Al K	Normal	1.19- 1.83	7.2047	0.0005	3383 / 20
Si K	Normal	1.50- 2.05	4.8796	0.0004	2204 / 220
Ca K	Normal	3.39- 4.30	1.9757	0.0010	520 / 6
P K	Normal	1.75- 2.38	4.9153	0.0028	1178 / 128

Chi_square = 4.0370

Element	Mass%	Atomic%	ZAF	Z	A	F
O	48.106	62.3021	1.1060	0.9888	1.1186	1.0000
Na	2.567	2.3135	1.3661	1.0402	1.3156	0.9983
Al	20.029	15.3810	1.3514	1.0145	1.3391	0.9947
Si	15.288	11.2788	1.5231	0.9905	1.5420	0.9972
Ca	4.262	2.2032	1.0486	1.0096	1.0387	1.0000
P	9.748	6.5213	0.9641	1.1723	0.8226	0.9999

Total 100.000 100.0000
Normalization factor = 2.0571

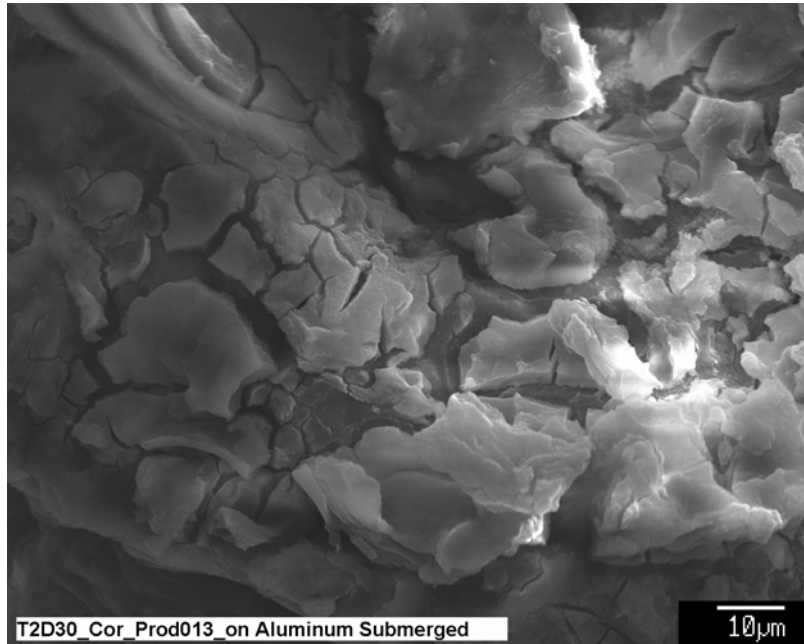


Figure B-23. SEM image at 1000× magnification of a Test #2, Day-30 sample of corrosion products on a submerged aluminum coupon. (T2D30_Cor_Prod013_on Aluminum Submerged)

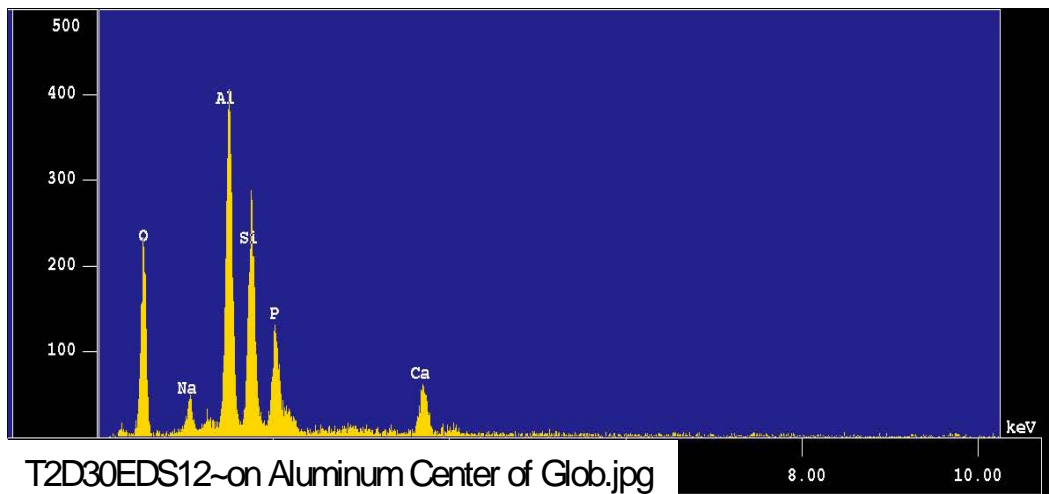


Figure B-24. EDS counting spectrum on the center of Figure B-23, suggesting that the corrosion products of aluminum are rich in aluminum, silicon, phosphorus, and oxygen. (T2D30EDS12~on Aluminum Center of Glob)

The results from the chemical composition analysis for T2D30EDS12 are given in Table B-7.

Table B-7. The Chemical Composition for T2D30EDS12

Mar 7 16:58 2005 /tmp/eds_pout.log Page 1

```

Group      : NRC
Sample     : T2D30 ID# : 12
Comment    : Corrosion product on Aluminum
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec   Aperture #   : 1
             Acc. Volt  : 20.0 KV      Probe Current : 3.388E-10 A
             Stage Point: X= 4.958 Y=60.774 Z=10.558
             Acq. Date  : Mon Mar 7 16:56:37 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	28.8019	0.0033	1875 /	7
Na K	Normal	0.81- 1.27	1.4361	0.0008	362 /	12
Al K	Normal	1.19- 1.83	8.1233	0.0005	3686 /	24
Si K	Normal	1.50- 2.05	5.8349	0.0004	2547 /	230
Ca K	Normal	3.39- 4.30	3.0762	0.0010	782 /	3
P K	Normal	1.75- 2.38	5.3699	0.0027	1244 /	145

 Chi_square = 3.9774

Element	Mass%	Atomic%	ZAF	Z	A	F
O	50.761	64.8096	1.0876	0.9891	1.0996	1.0000
Na	3.268	2.9041	1.4045	1.0406	1.3517	0.9985
Al	18.215	13.7895	1.3837	1.0150	1.3700	0.9951
Si	14.298	10.3989	1.5122	0.9909	1.5297	0.9976
Ca	5.190	2.6450	1.0411	1.0101	1.0306	1.0000
P	8.269	5.4530	0.9502	1.1728	0.8104	0.9998

 Total 100.000 100.0000
 Normalization factor = 1.6205