

## Appendix F

### SEM/EDS Data for Test #3, Day-30 Flow Meter

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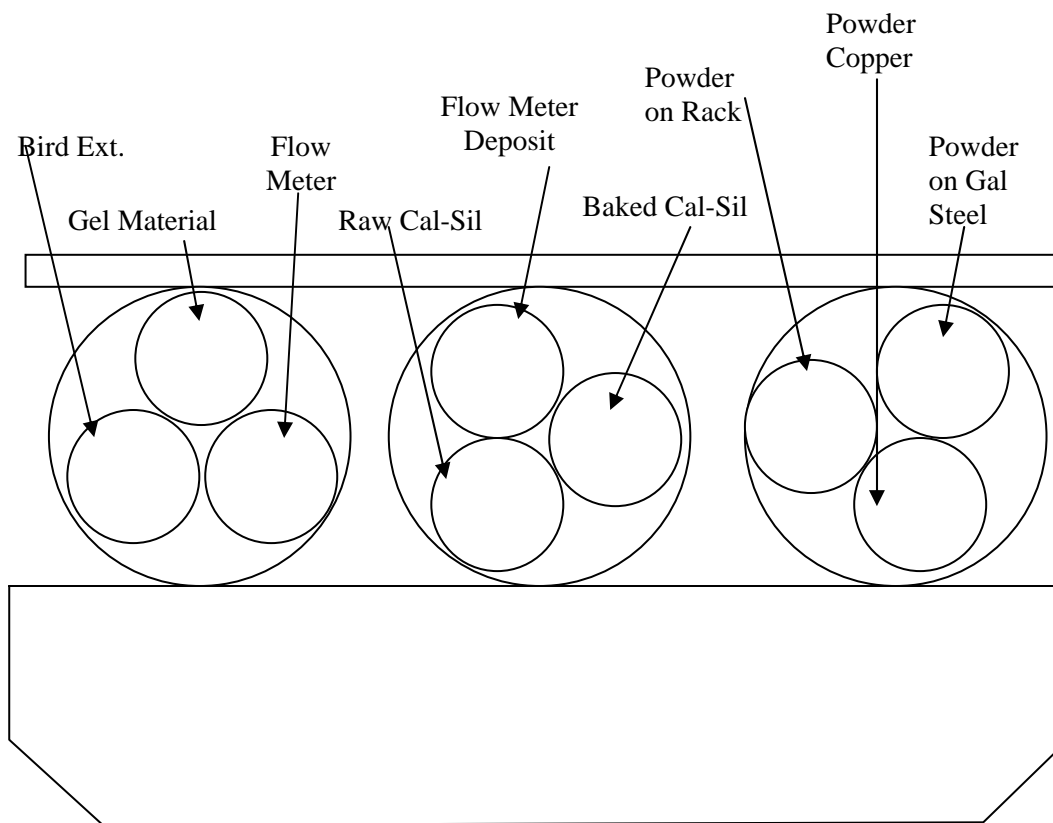
In ICET Test #3, significant amounts of debris and precipitates were found within the flow meter. SEM/EDS analysis was performed to examine the composition of the debris trapped in the flow meter, as well as the white precipitates deposited on the inner wall of the flow meter. The debris and the precipitates were collected on May 5, 2005, the date Test #3 was shut down. The samples were dried in air before being coated with Au/Pd for SEM examination. 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 May 9, 2005.

Test #3, Day-30 Flow Meter



### Flow Meter Debris

Image: T3D30FlwMetrDebris005 80 ×

Figure F-1

T3D30FlwMetrDebris006 600 ×

Figure F-2

EDS: T3D30FlwDebris03

Figure F-3

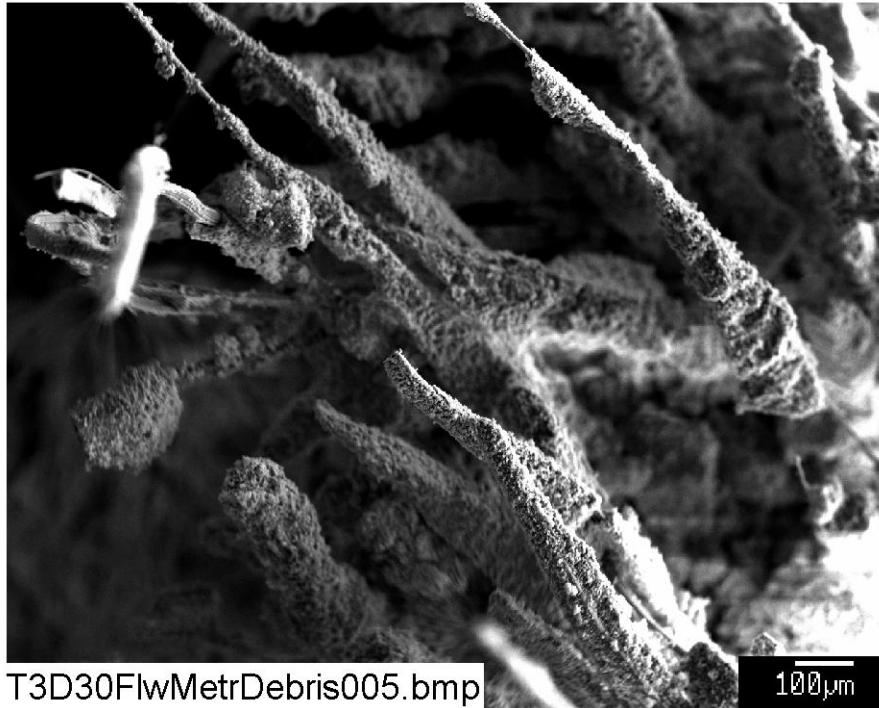
### Flow Meter Deposits

Image: T3~Flow Meter 200 ×

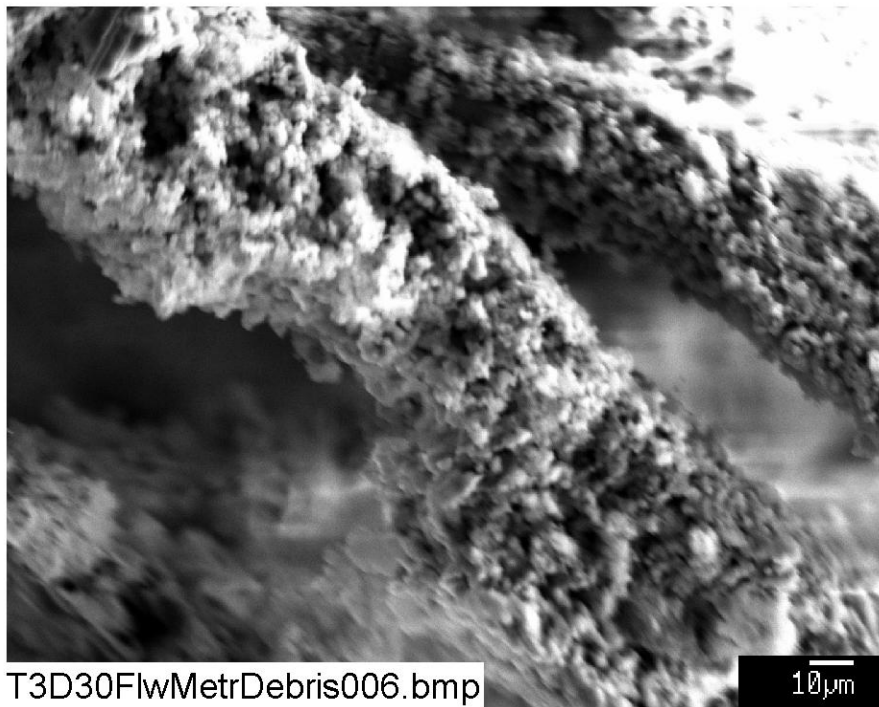
Figure F-4

EDS: T3Deposits08

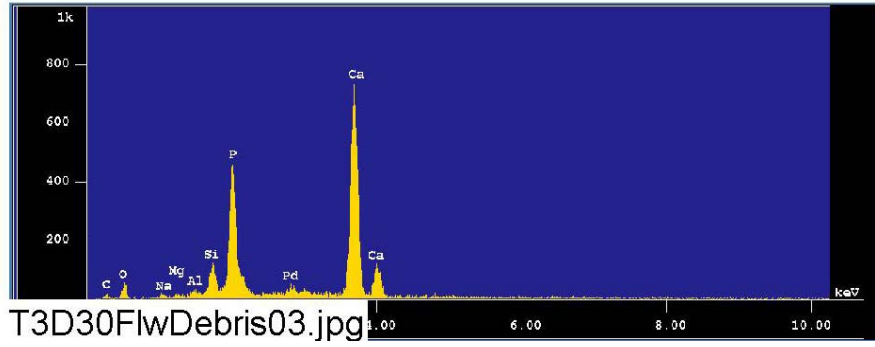
Figure F-5



**Figure F-1.** SEM image magnified 80 times for Test #3, Day-30 debris within the flow meter. (T3D30FlwMetrDebris005)



**Figure F-2.** SEM image magnified 600 times for Test #3, Day-30 debris within the flow meter. (T3D30FlwMetrDebris006)



**Figure F-3. EDS counting spectrum for the coatings on the fibers shown in Figure F-2. (T3D30FlwDebris03)**

The results from the chemical composition analysis for T3D30FlwDebris03 are given in Table F-1.

**Table F-1. Chemical Compositions for T3D30FlwDebris03, Figure F-3**

May 9 2005

Group : NRC  
 Sample : T3D30 ID# : 3  
 Comment : Flowmeter Debris  
 Condition : Full Scale : 20KeV(10eV/ch,2Kch)  
           Live Time : 60.000 sec Aperture # : 1  
           Acc. Volt : 15.0 KV Probe Current : 1.596E-09 A  
           Stage Point : X=77.422 Y=68.992 Z=12.516  
           Acq. Date : Mon May 9 12:10:19 2005

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
O K	Normal	0.25- 0.77	1.1291	0.0010	422 / 12
Si K	Normal	1.50- 2.05	0.6220	0.0004	899 / 142
P K	Normal	1.75- 2.38	4.6152	0.0040	4117 / 58
Ca K	Normal	3.39- 4.30	12.9947	0.0033	9129 / 16
C K	Normal	0.09- 0.46	0.1025	0.0001	57 / 9
Pd L	Normal	2.22- 3.81	0.5748	0.0010	419 / 35
Al K	Normal	1.19- 1.83	0.0834	0.0002	129 / 24
Na K	Normal	0.81- 1.27	0.0806	0.0004	86 / 10
Mg K	Normal	0.97- 1.57	0.0536	0.0001	84 / 15

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 Chi\_square = 8.9413

Element	Mass%	Atomic%	ZAF	Z	A	F
O	15.028	28.4942	2.9323	0.9460	3.0996	1.0000
Si	3.174	3.4286	1.1244	0.9475	1.1960	0.9922
P	17.384	17.0260	0.8298	1.1366	0.7330	0.9960
Ca	57.802	43.7487	0.9799	0.9630	1.0176	1.0000
C	1.833	4.6300	3.9385	0.9925	3.9689	0.9999
Pd	3.395	0.9679	1.3011	1.3345	0.9949	0.9799
Al	0.487	0.5473	1.2851	0.9696	1.3304	0.9962
Na	0.538	0.7099	1.4707	0.9973	1.4750	0.9999
Mg	0.359	0.4474	1.4751	0.9384	1.5740	0.9987

-----  
 Total 100.000 100.0000  
 Normalization factor = 4.5392



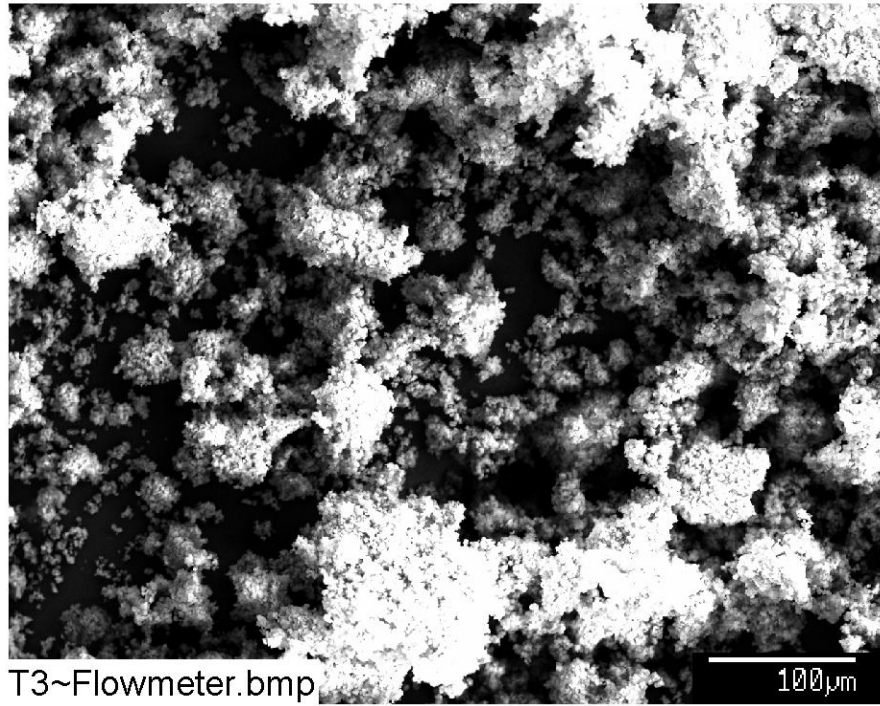


Figure F-4. SEM image magnified 200 times for Test #3, Day-30 deposits on the inner wall of the flow meter. (T3~Flowmeter)

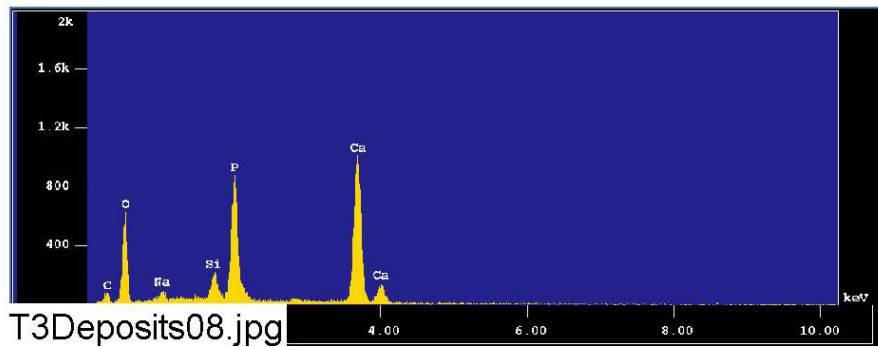


Figure F-5. EDS counting spectrum for the large masses of particulate deposits shown in Figure F-4. (T3Deposits08)

The results from the chemical composition analysis for T3Deposits08 are given in Table F-2.

Table F-2. Chemical Compositions for T3Deposits08, Figure F-5

May 9 2005

Group : NRC  
 Sample : T3D30 ID# : 8  
 Comment : Flowmeter Deposits  
 Condition : Full Scale : 20KeV(10eV/ch,2Kch)  
           Live Time : 60.000 sec Aperture # : 1  
           Acc. Volt : 15.0 KV Probe Current : 1.607E-09 A  
           Stage Point : X=47.897 Y=71.447 Z=12.516  
           Acq. Date : Mon May 9 14:45:11 2005

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
C K	Normal	0.09- 0.46	0.5235	0.0004	292 / 100
O K	Normal	0.25- 0.77	10.8619	0.0030	4085 / 54
Na K	Normal	0.81- 1.27	0.2843	0.0009	307 / 44
Si K	Normal	1.50- 2.05	1.0559	0.0005	1537 / 258
P K	Normal	1.75- 2.38	8.7448	0.0054	7854 / 123
Ca K	Normal	3.39- 4.30	17.8554	0.0039	12630 / 21

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 Chi\_square = 35.5886

Element	Mass%	Atomic%	ZAF	Z	A	F
C	3.939	7.2812	3.8083	1.0178	3.7418	0.9999
O	43.460	60.3090	2.0251	0.9706	2.0865	1.0000
Na	0.842	0.8134	1.4997	1.0240	1.4645	1.0000
Si	2.376	1.8782	1.1389	0.9739	1.1772	0.9933
P	14.513	10.4028	0.8400	1.1688	0.7203	0.9976
Ca	34.870	19.3155	0.9884	0.9928	0.9956	1.0000

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 Total 100.000 100.0000  
 Normalization factor = 1.9758  
 Total 100.000 100.0000  
 Normalization factor = 2.1120

## Appendix G

### SEM/EDS and ESEM/EDS Data for Test #3, Day-30 Gel

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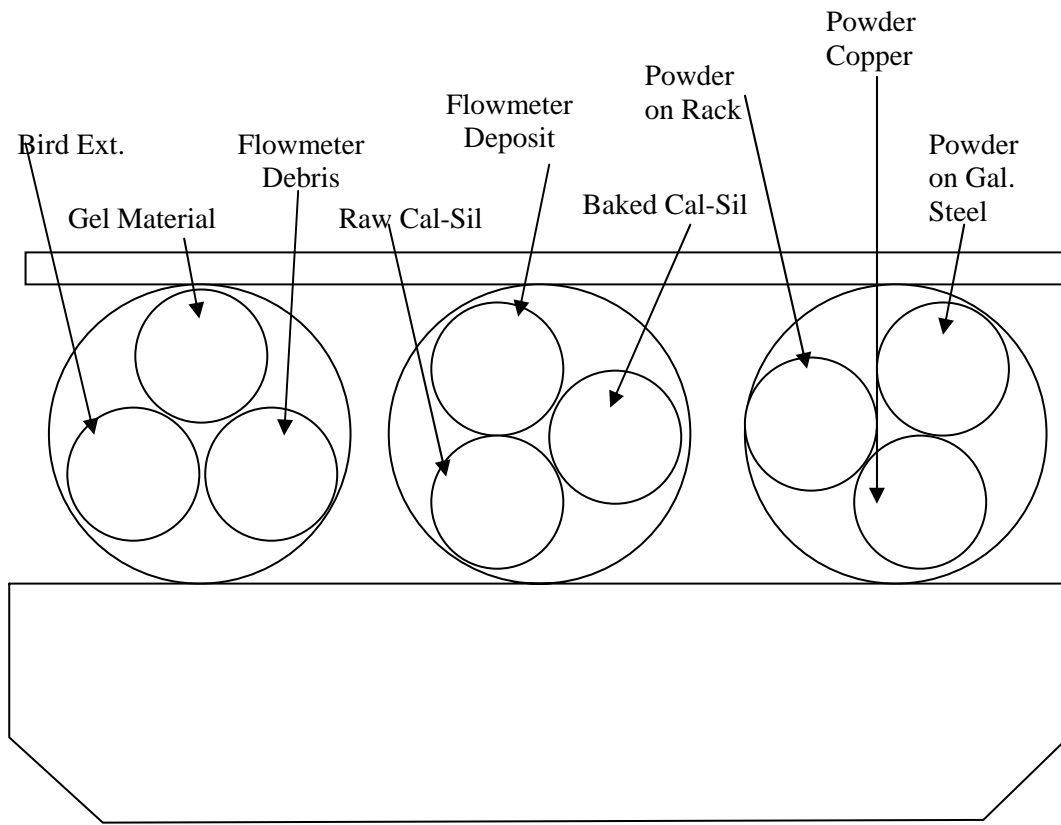
In ICET Test #3, one distinguished phenomenon is the presence of white gel-like precipitates in the testing solution. On the shutdown date of Test #3, deposits of the white gel-like precipitates were observed on the top of the birdcage. These precipitates may increase the containment sump screen head loss during a LOCA; therefore, it is necessary to investigate the morphology and composition of the white gel-like precipitate.

This appendix shows the ESEM/SEM/EDS and XRD/XRF results of the white gel-like precipitates. The precipitates were collected on the date Test #3 was shut down (May 5, 2005). For the SEM examination, the samples were dried in air before being coated with Au/Pd. EDS results provide a semi-quantitative elemental analysis of the sample compositions. Also, XRD results show the crystal structure of the white gel-like precipitates. Based on the XRD results, the composition of the white gel-like precipitates contained crystalline substances of sodium calcium hydrogen carbonate phosphate hydrate  $[\text{Ca}_8\text{H}_2(\text{PO}_4)_6 \cdot \text{H}_2\text{O} \cdot \text{NaHCO}_3 \cdot \text{H}_2\text{O}]$  and lithium calcium hydrogen carbonate phosphate hydrate  $[\text{Ca}_8\text{H}_2(\text{PO}_4)_6 \cdot \text{H}_2\text{O} \cdot \text{Li}_2\text{CO}_3 \cdot \text{H}_2\text{O}]$ . In addition, XRF results indicate the chemical composition of the precipitates. 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 May 9, 2005.  
Test #3, Day-30 Gel Material



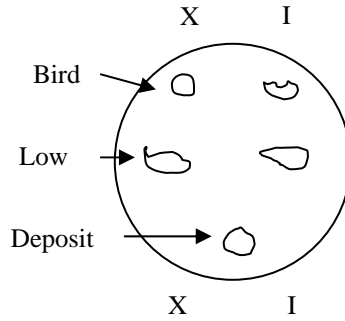
## Gel Material

Image:	T3D30GelMaterial003	100 ×	Figure G-1
	T3D30GelMaterial004	1000 ×	Figure G-2
EDS:	T3D30Gel02	Whole screen of image 004	Figure G-3

## Transcribed Laboratory Log

Laboratory session from May 6, 2005.

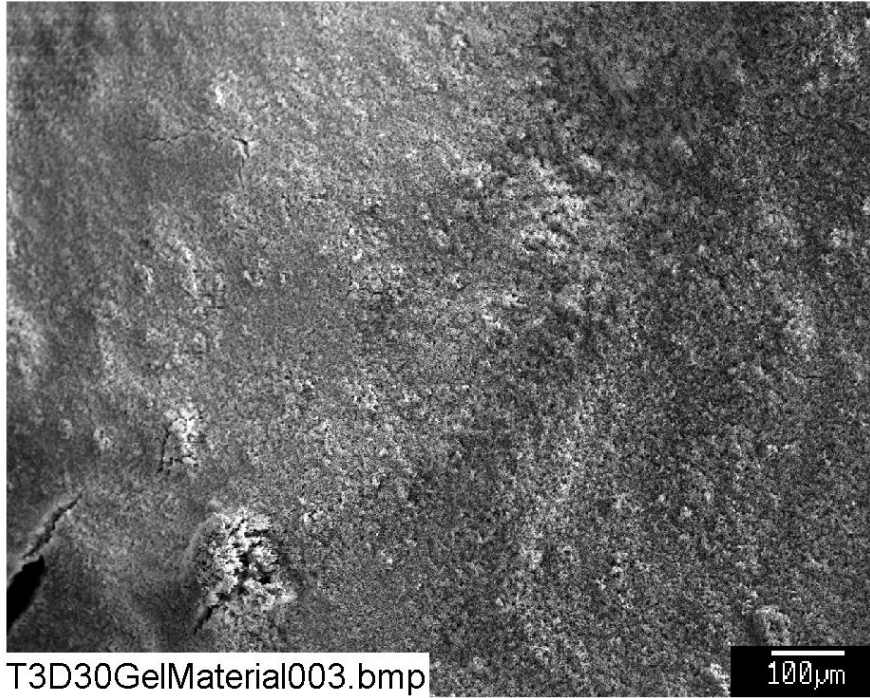
Test #3, Day-30 Gel Material



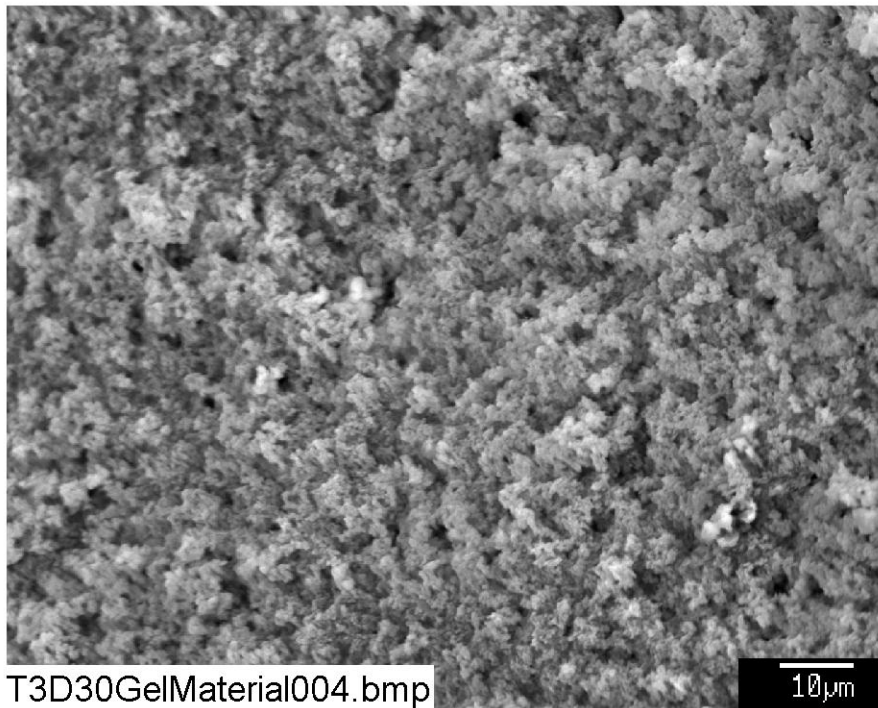
### Gel-Like Material on Top of Birdcage

Image:	t3Gel08	1000 ×	Figure G-4
EDS:	t3GelED4	White gel has high C and low Si	Figure G-5
	t3geled5	Comparing t3bcexe2 from Appendix C4 & t3GelED4	Figure G-6
	t3geled6	EDS of gel material	Figure G-7
	t3geled7	Comparing t3bcexe2 from Appendix C4 & EDS6	Figure G-8





**Figure G-1.** SEM image magnified 100 times for a Test #3, Day-30 white gel-like material on the top of the birdcage. (T3D30GelMaterial003)



**Figure G-2.** SEM image magnified 1000 times for a Test #3, Day-30 white gel-like material on the top of the birdcage. (T3D30GelMaterial004)

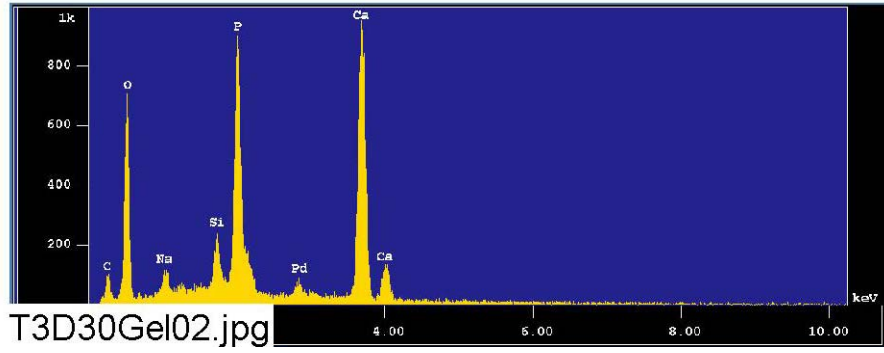


Figure G-3. EDS counting spectrum for the white gel-like material (whole image) shown in Figure G-2. (T3D30Gel02)

The results from the chemical composition analysis for T3D30Gel02 are given in Table G-1.

**Table G-1. Chemical Compositions for T3D30Gel02, Figure G-3**

May 9 2005

Group : NRC  
 Sample : T3D30 ID# : 2  
 Comment : GelMaterial  
 Condition : Full Scale : 20KeV(10eV/ch,2Kch)  
           Live Time : 60.000 sec Aperture # : 1  
           Acc. Volt : 15.0 KV Probe Current : 1.606E-09 A  
           Stage Point : X=79.625 Y=59.260 Z=11.424  
           Acq. Date : Mon May 9 11:42:11 2005

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
C K	Normal	0.09- 0.46	0.6057	0.0005	338 / 119
O K	Normal	0.25- 0.77	12.2043	0.0032	4587 / 68
Na K	Normal	0.81- 1.27	0.5675	0.0010	613 / 50
Si K	Normal	1.50- 2.05	0.9391	0.0005	1366 / 271
P K	Normal	1.75- 2.38	8.4975	0.0055	7628 / 107
Ca K	Normal	3.39- 4.30	17.1295	0.0038	12109 / 26

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 Chi\_square = 42.7915

Element	Mass%	Atomic%	ZAF	Z	A	F
C	4.355	7.8616	3.7318	1.0194	3.6611	0.9999
O	45.521	61.6928	1.9361	0.9721	1.9917	1.0000
Na	1.639	1.5456	1.4989	1.0256	1.4614	1.0000
Si	2.072	1.5994	1.1451	0.9756	1.1812	0.9937
P	13.776	9.6435	0.8415	1.1708	0.7203	0.9978
Ca	32.638	17.6571	0.9890	0.9947	0.9943	1.0000

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 Total 100.000 100.0000  
 Normalization factor = 1.9265  
 Total 100.000 100.0000  
 Normalization factor = 2.1120

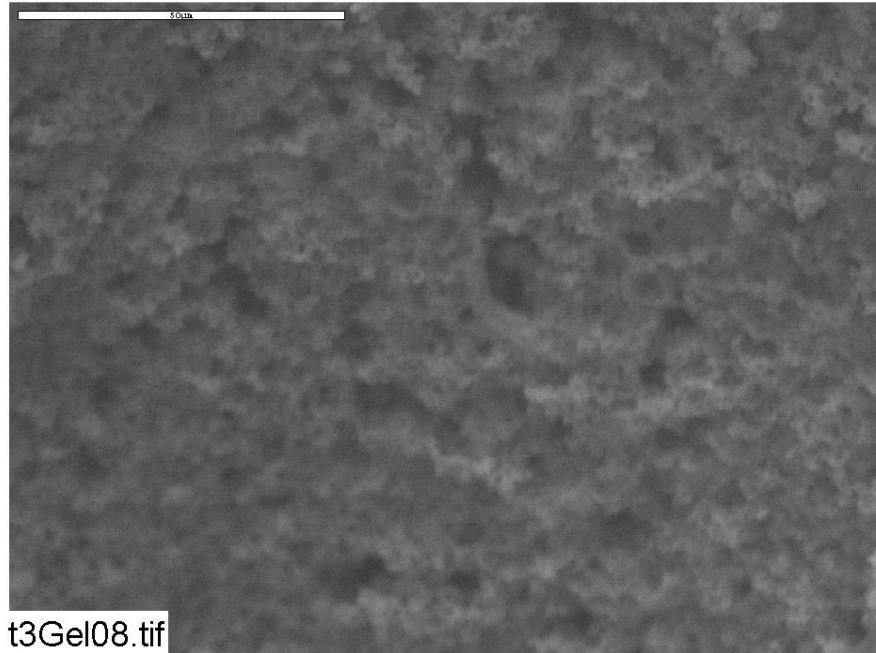


Figure G-4. ESEM image magnified 1000 times for a Test #3, Day-30 white gel-like material on the top of the birdcage. (t3Gel08)

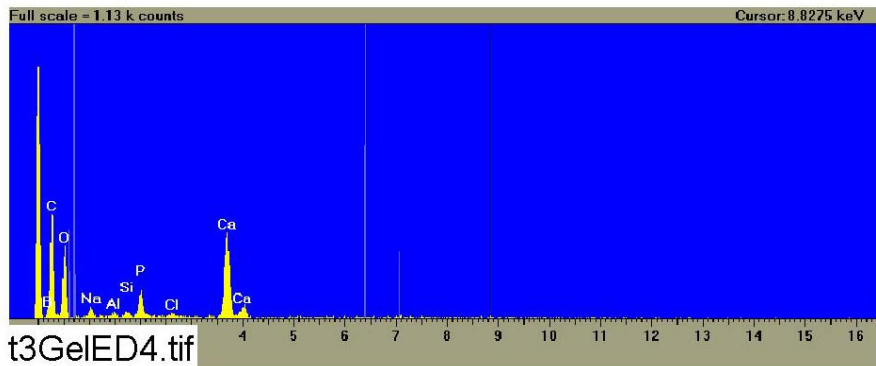


Figure G-5. EDS counting spectrum for the white gel-like material shown in Figure G-4. (t3GelED4)

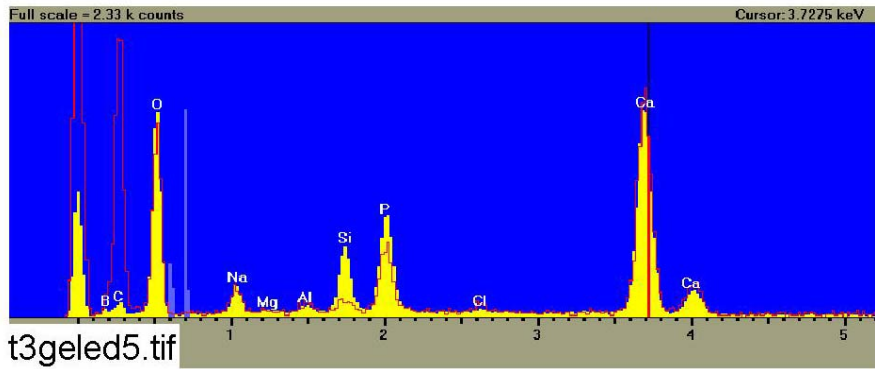


Figure G-6. Comparison of EDS counting spectra for Figure G-5 (red, the gel-like materials shown in Figure G-4) and Figure C4-5 (yellow, the large deposits taken from the birdcage exterior shown in Figure C4-4). (t3geled5)

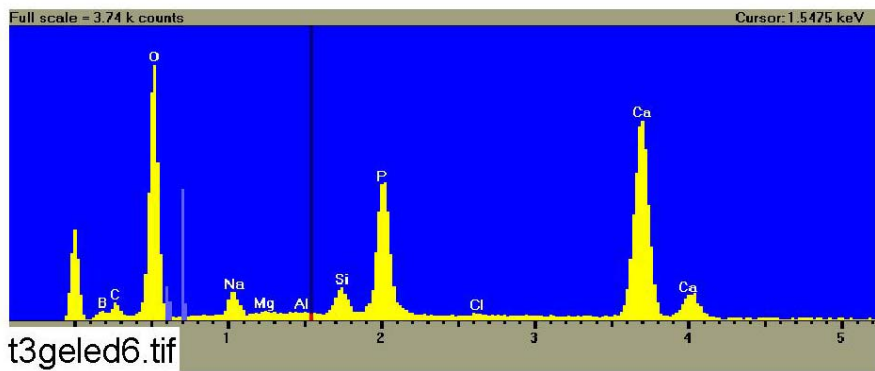
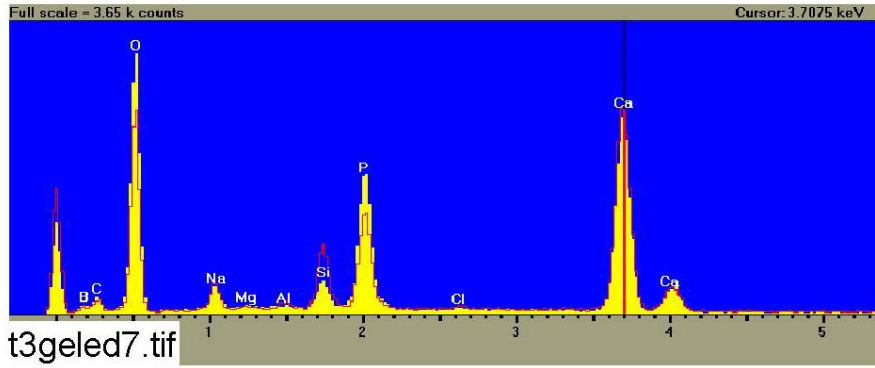
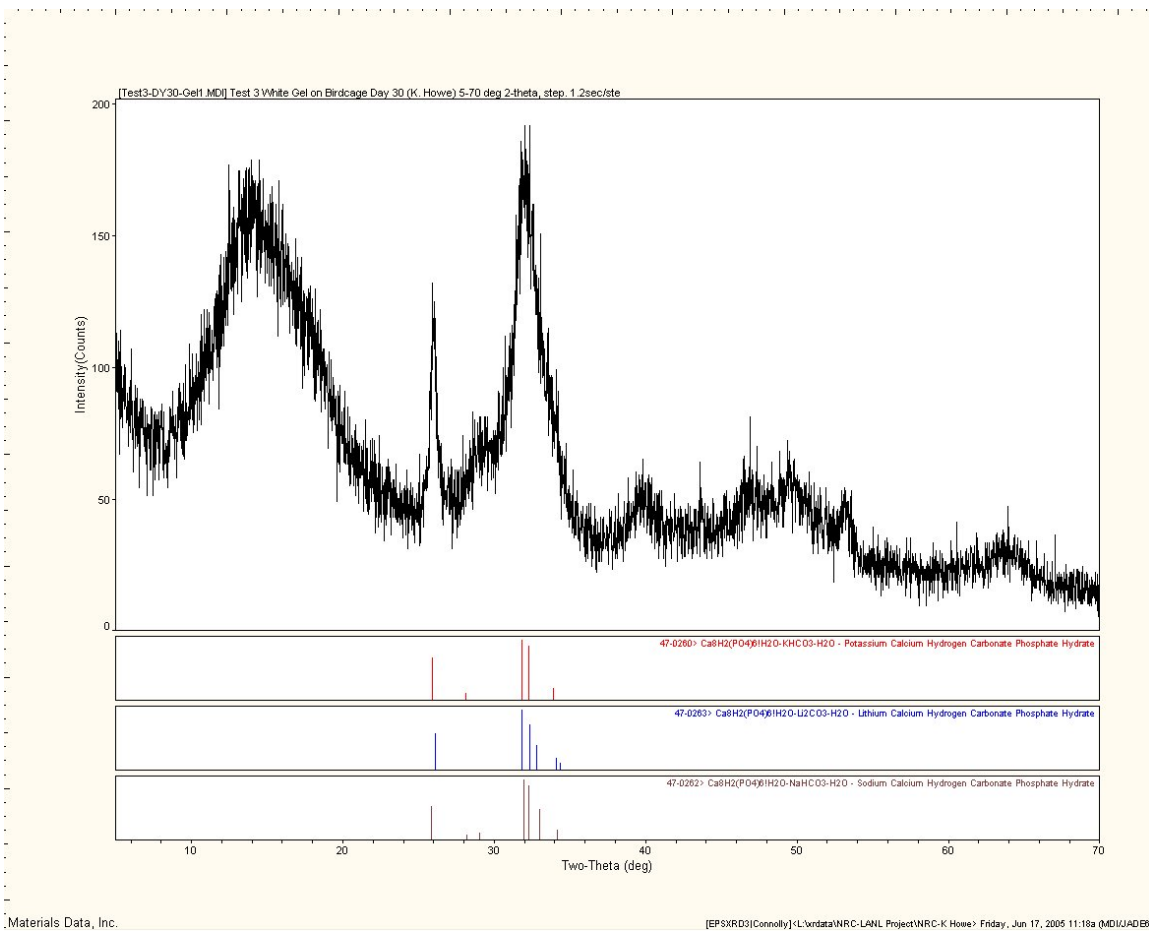


Figure G-7. Another EDS counting spectrum for the white gel-like material shown in Figure G-4. (t3geled6)



**Figure G-8.** Comparison of EDS counting spectra for Figure G-7 (yellow, the gel-like materials shown in Figure G-4) and Figure C4-5 (red, the large deposits taken from the birdcage exterior shown in Figure C4-4). (t3geled7)



**Figure G-9.** XRD results for Test #3, Day-30 white gel-like material.

**Table G-2. Dry Mass Composition of a Test #3, Day 30 White Gel-Like Sample by XRF Analysis**

<b>Sample ID</b>	<b>SiO<sub>2</sub></b>	<b>TiO<sub>2</sub></b>	<b>Al<sub>2</sub>O<sub>3</sub></b>	<b>Fe<sub>2</sub>O<sub>3</sub></b>	<b>FeO</b>	<b>MnO</b>	<b>MgO</b>	<b>CaO</b>	<b>Na<sub>2</sub>O</b>	<b>K<sub>2</sub>O</b>	<b>H<sub>2</sub>O(-)</b>	<b>H<sub>2</sub>O(+)</b>	<b>CO<sub>2</sub></b>	<b>P<sub>2</sub>O<sub>5</sub></b>	<b>Total</b>	<b>H<sub>2</sub>O(+)/CO<sub>2</sub> /DF (10) &amp; Cover. To %</b>
<b>Test #3, Day 30 White Gel</b>	5.26	0.02	0.63	0.07	0.00	0.00	0.25	35.01	2.39	0.06	4.75	19.24	27.09	94.77	1.0196	

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