

# **ICE-T RF06 – single particle results from ambient and CVI sample**

**Emphasis on carbonaceous particles  
(also Cu artifacts in CVI samples if we have time)**

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## Main particle types observed

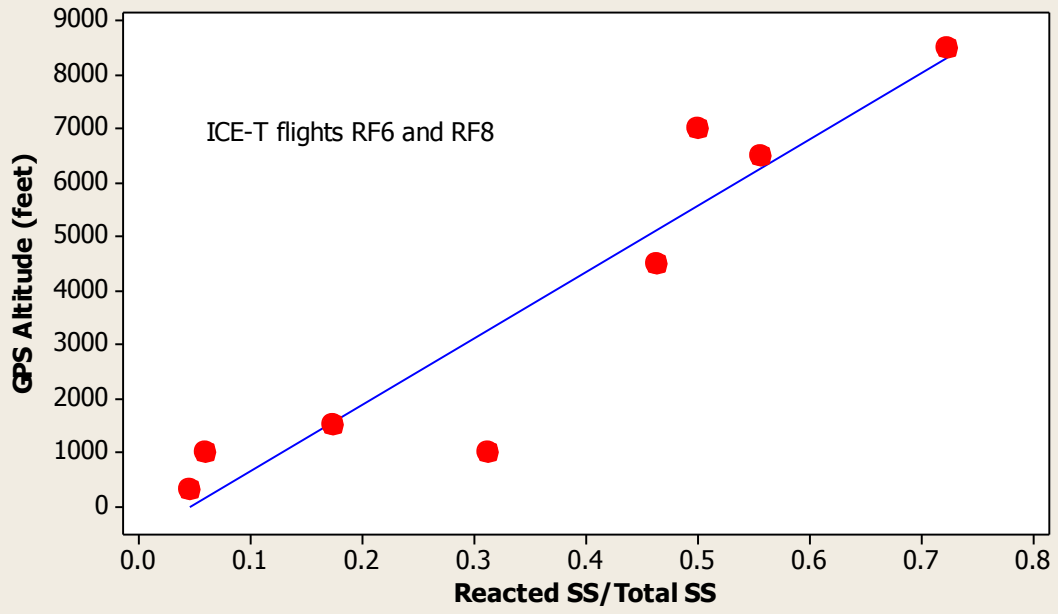
Ambient filter samples, 0.1 to about 3  $\mu\text{m}$  diameter)

GNI samples, 1  $\mu\text{m}$  and larger  $\mu\text{m}$

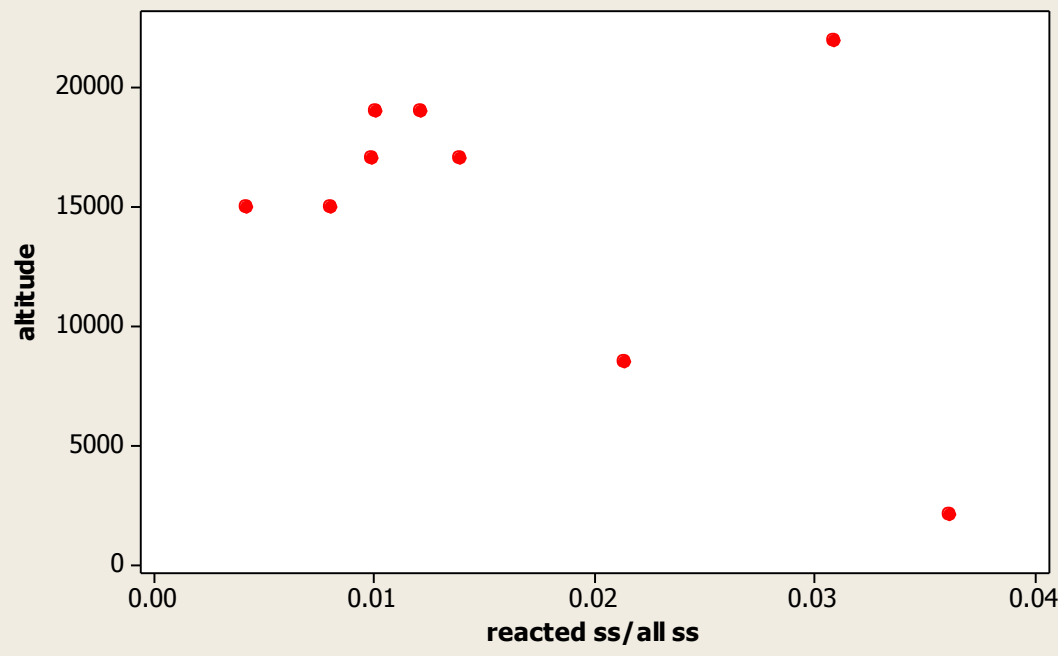
CVI samples, 0.1 and larger (largest typically 3-5)

- Dust – consisting mostly of quartz ( $\text{SiO}_2$ ) and clays (smectite/illite mixtures and much less kaolinite)
- Sea salt (NaCl + mixed cation sulfate)
- Ammonium sulfate
- Reacted sea salt (sodium sulfate and possibly sodium nitrate)
- Carbonaceous particles – some clearly biogenic, some from combustion, a few both (char)
- Various aggregated combinations of these types

**GPS altitude vs ratio of reacted seasalt to total seasalt (number conc.)**



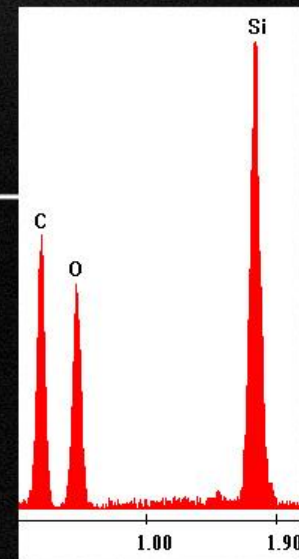
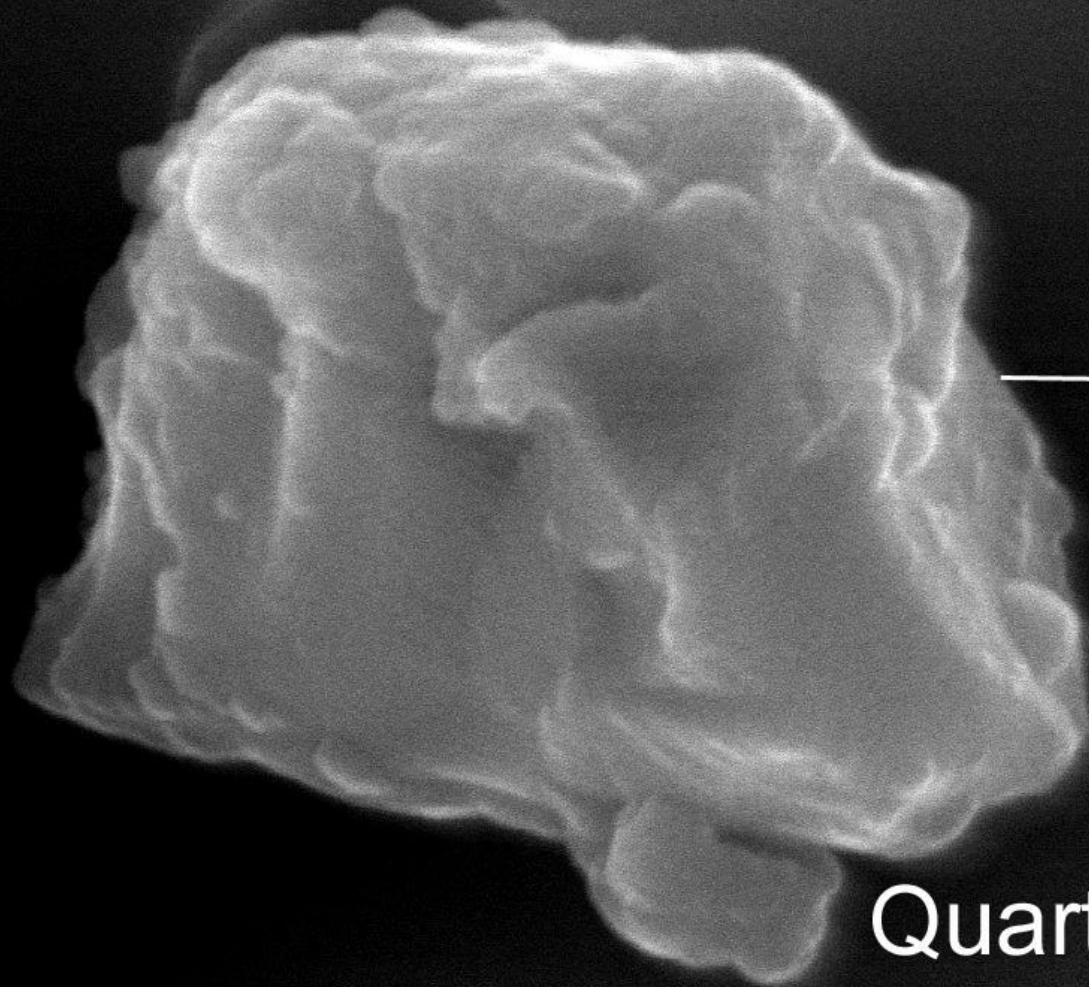
**Ambient**



**CVI**



ICE-T RF8 13:00:30-13:03:45 7/22/2011  
1000'



Quartz ( $\text{SiO}_2$ )

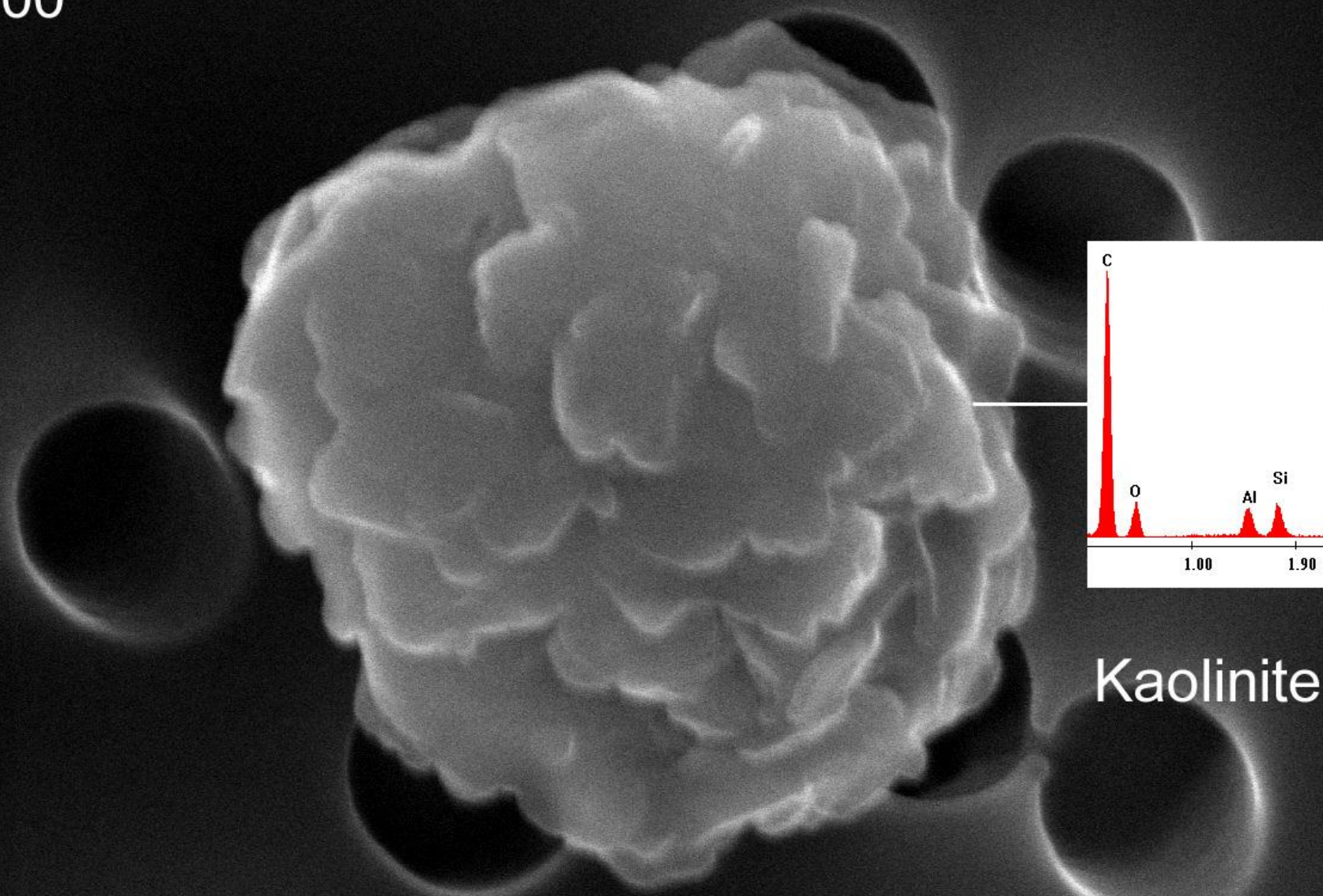
J. Anderson and X. Hua  
Arizona State University

10.0kV 13.6mm x50.0k SE(U) 9/28/11 15:06

1.00um



ICE-T RF8 13:09-13:24 7/22/2011  
4500'



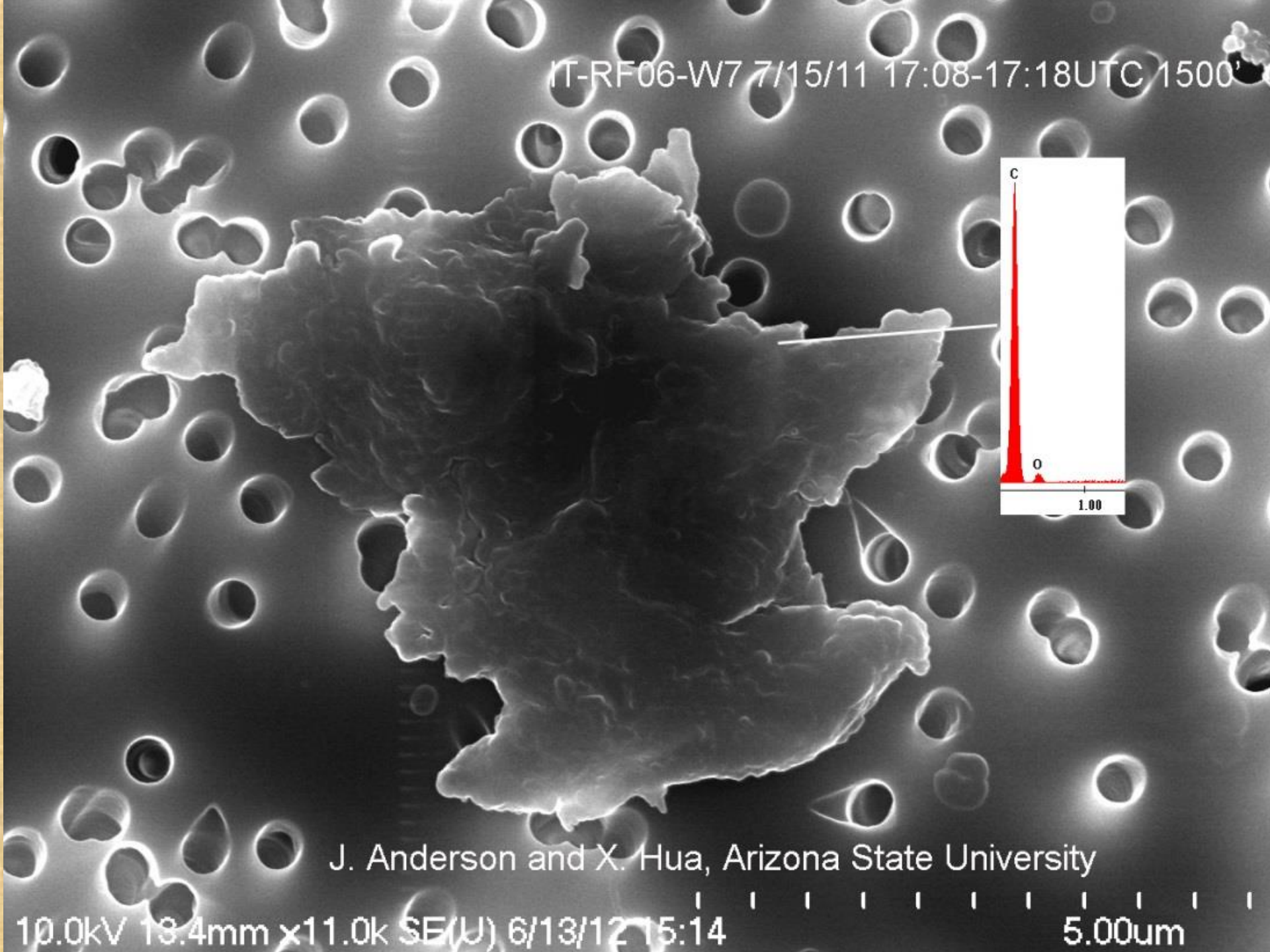
Kaolinite

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10.0kV 13.6mm x40.0k SE(U) 9/28/11 16:07

1.00um

IT-RF06-W7 7/15/11 17:08-17:18UTC 1500



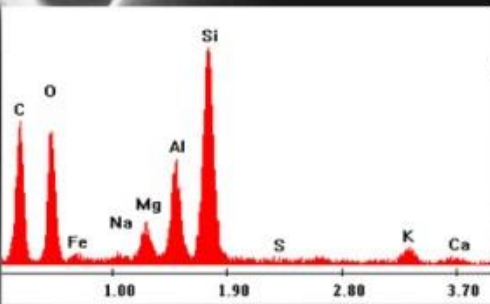
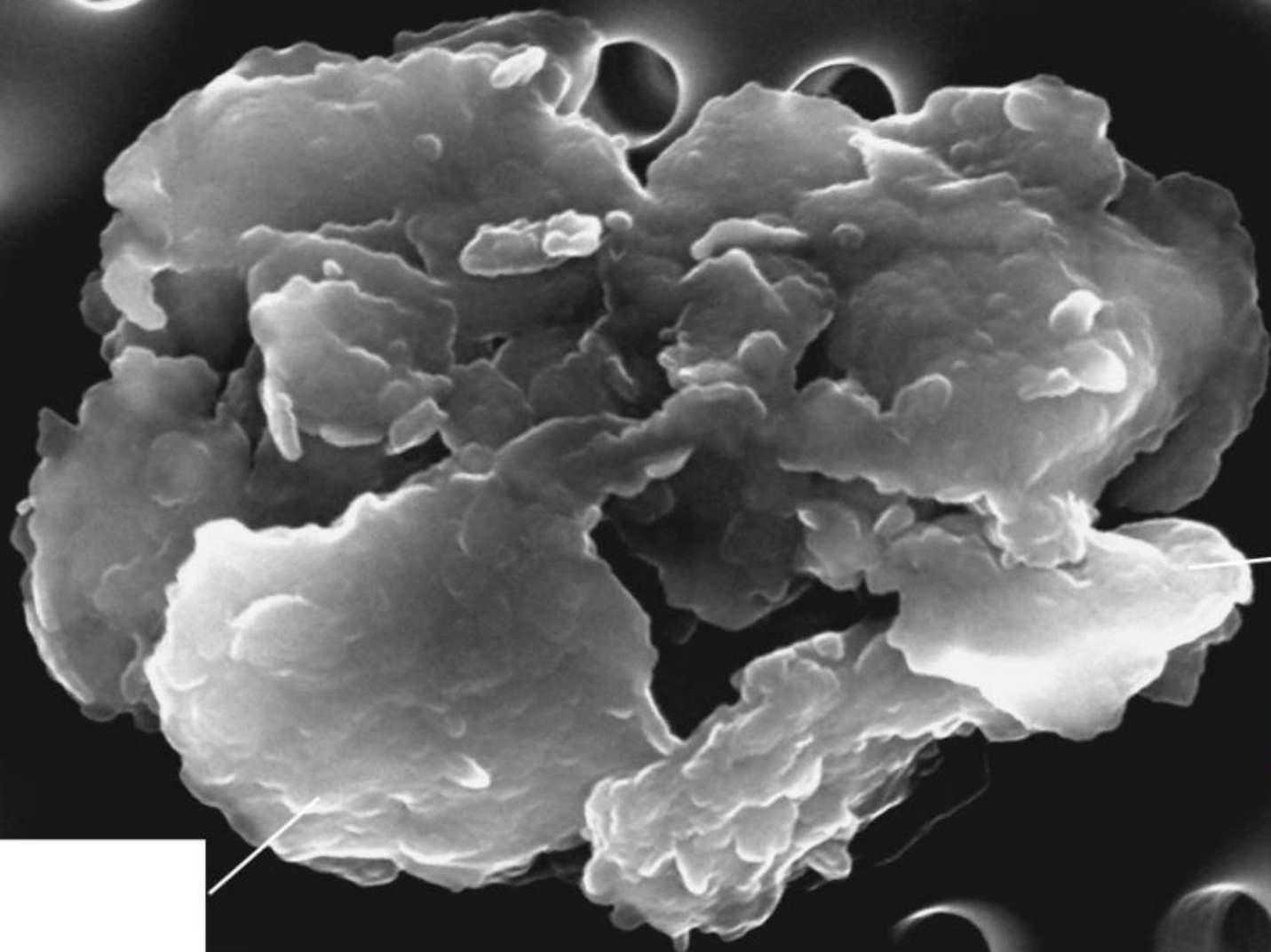
J. Anderson and X. Hua, Arizona State University

10.0kV 18.4mm x11.0k SE(U) 6/13/12 15:14

5.00um



IT-RF06 7/15/11 13:45-13:50 UTC (6500' and climbing)



J. Anderson and X. Hua, Arizona State University

10.0kV 13.1mm x18.0k SE(U) 6/11/12 15:32

3.00um

ICE-T RF8-W3, 4500'

13:09-13:24 7/22/2011

Biogenic fragment

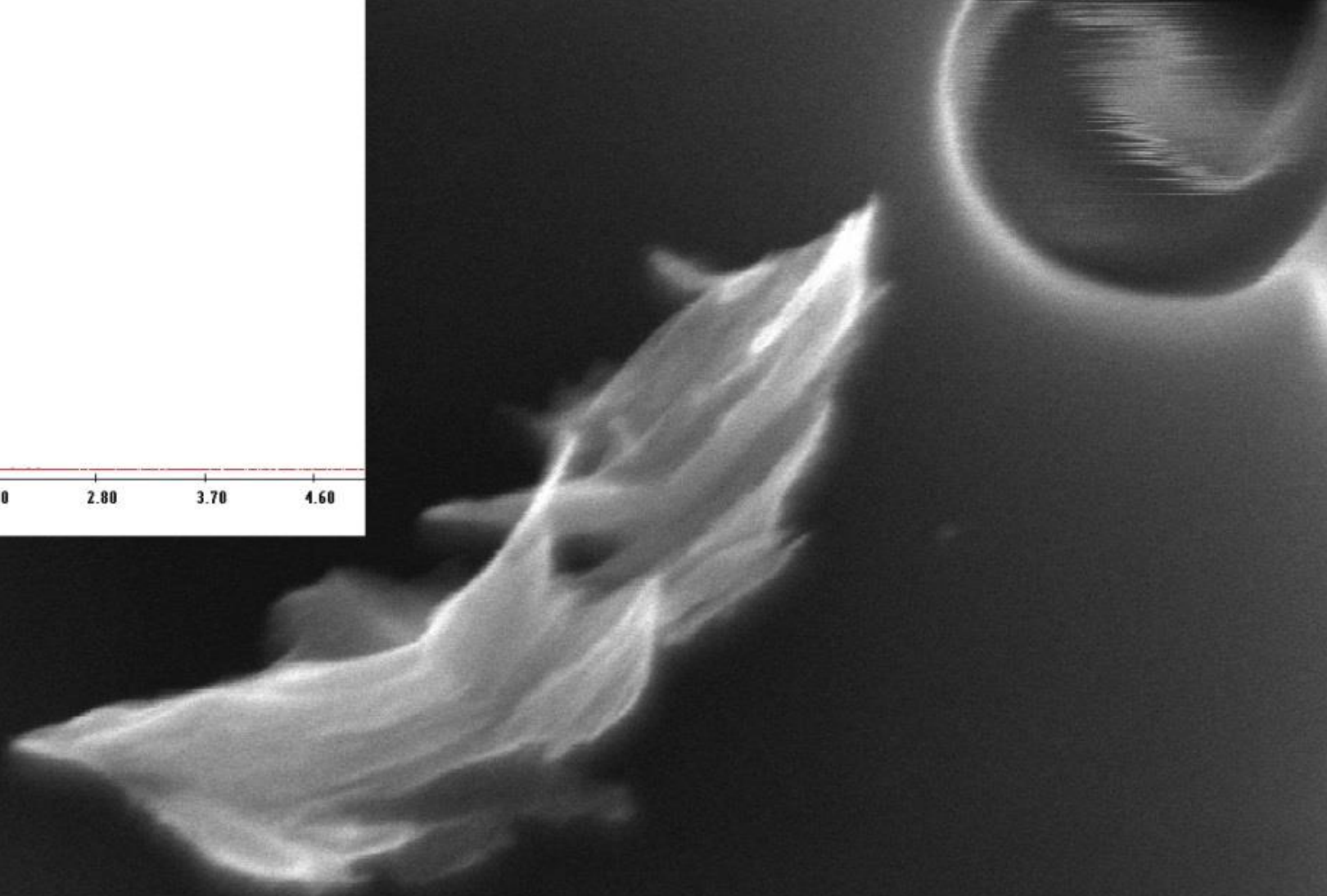
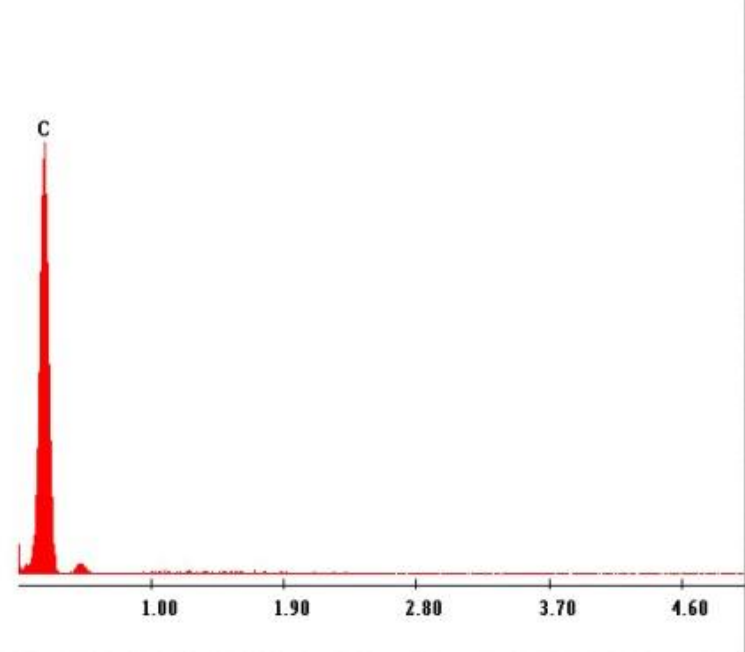


J. Anderson and X. Hua, Arizona State University

10.0kV 13.6mm x7.00k SE(U) 9/28/11 15:54

5.00um





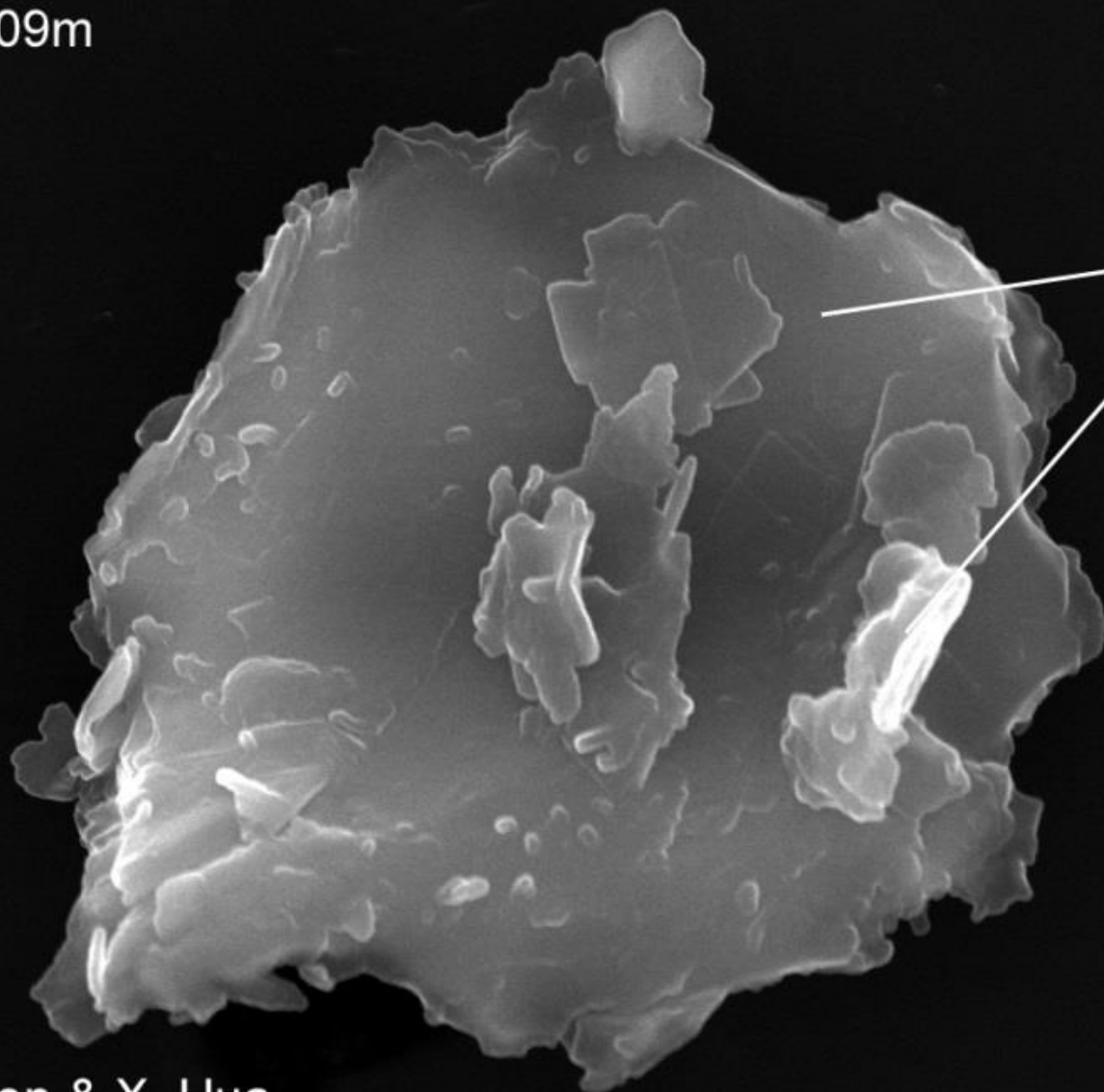
ICE-T RF8-W1, 300'  
7/22/11 12:28:00-12:44:07

J. Anderson and X. Hua  
Arizona State University

10.0kV 13.7mm x70.1k SE(U) 9/28/11 13:34

500nm

IT-RF8-GNI 12:35:36-12:35:43  
7/22/11 109m



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Arizona State University

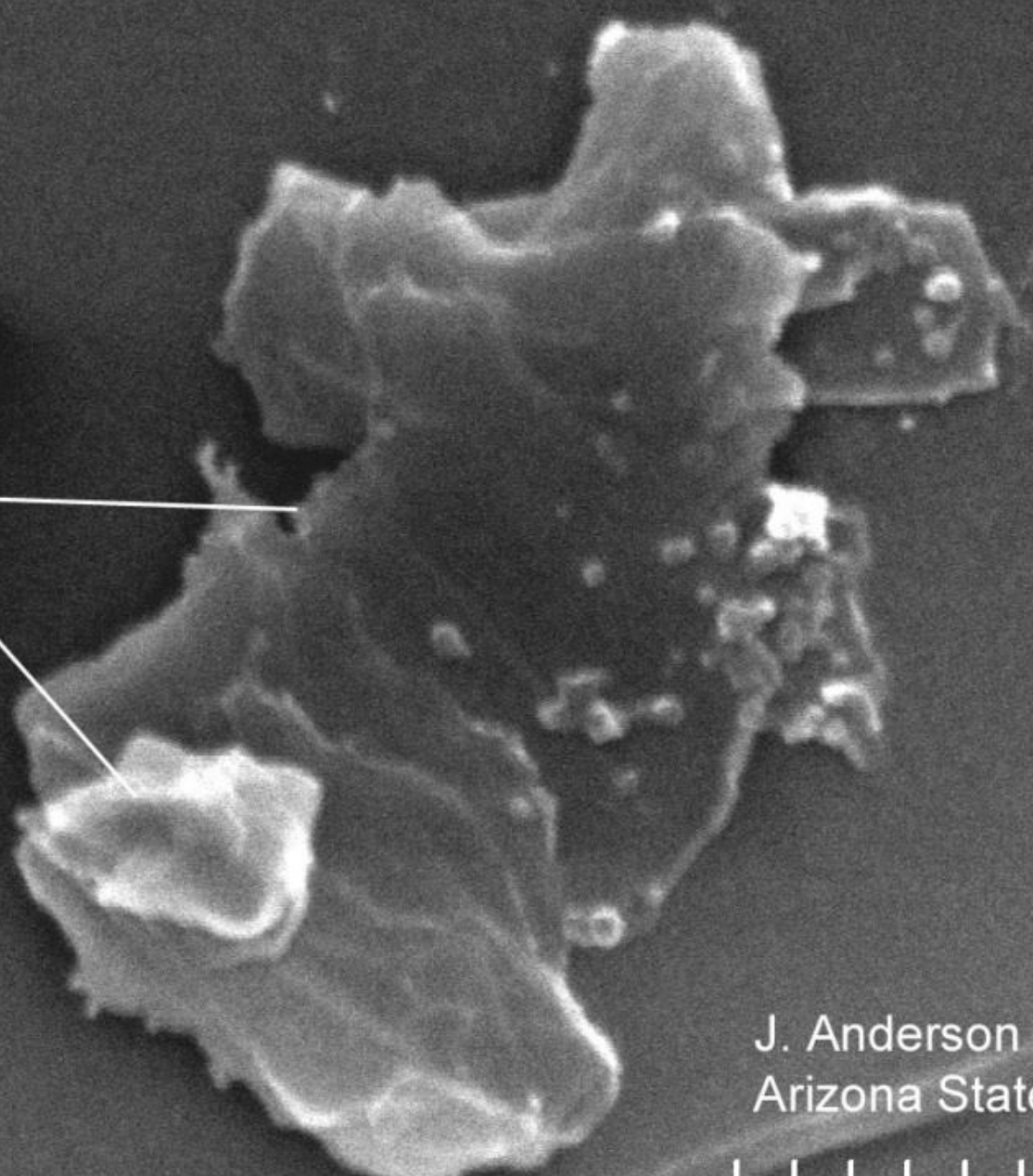
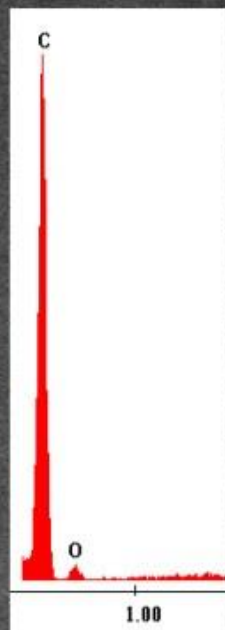
15.0kV 13.5mm x8.00k SE(U) 1/12/12 13:33

5.00um



IT-RF8-GNI 12:51:31-12:51:38

7/22/11 330m



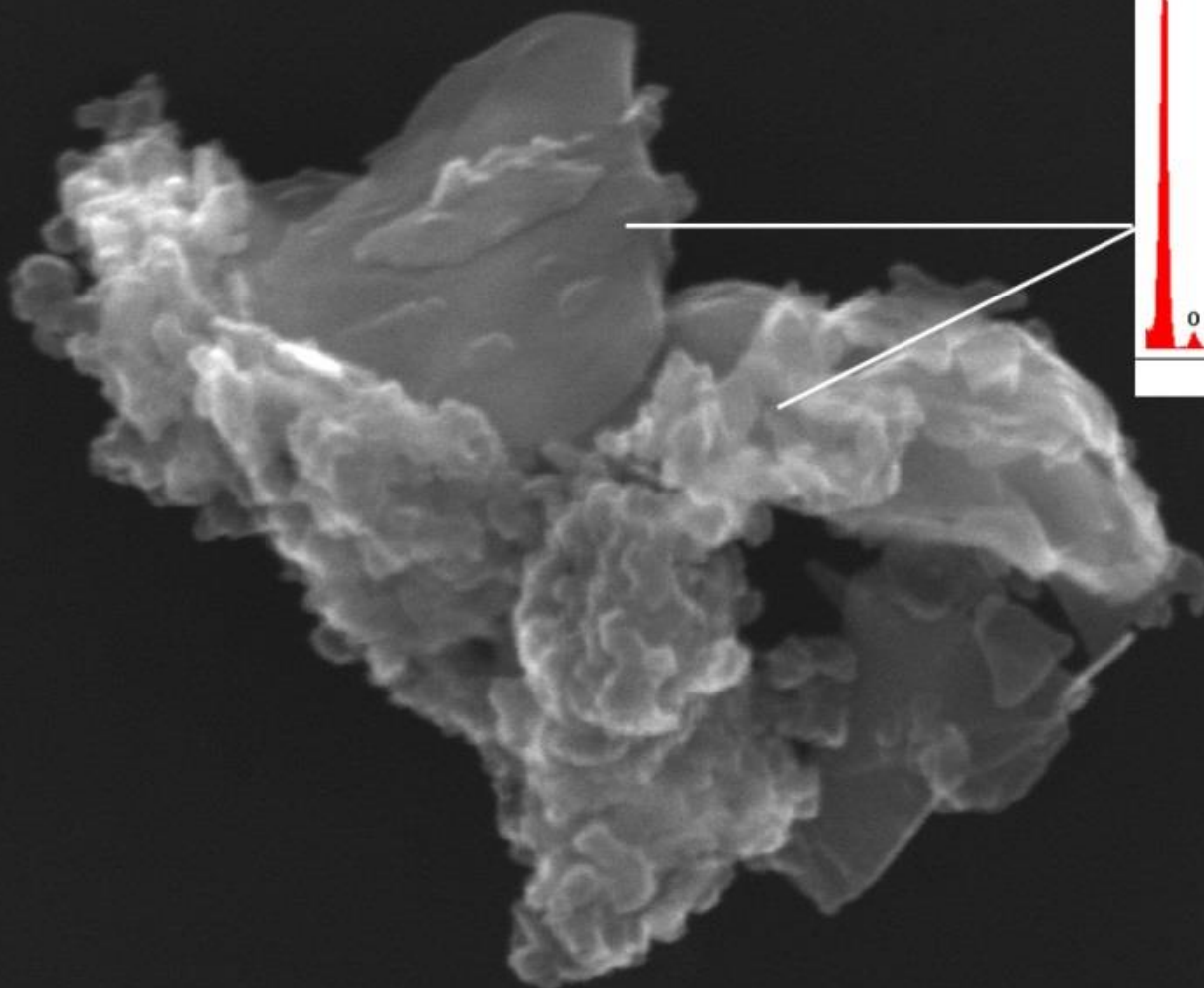
J. Anderson & X. Hua  
Arizona State University

15.0kV 13.4mm x80.1k SE(U) 1/12/12 14:45

500nm

IT-RF8-GNI 12:35:36-12:35:43

7/22/11 109m



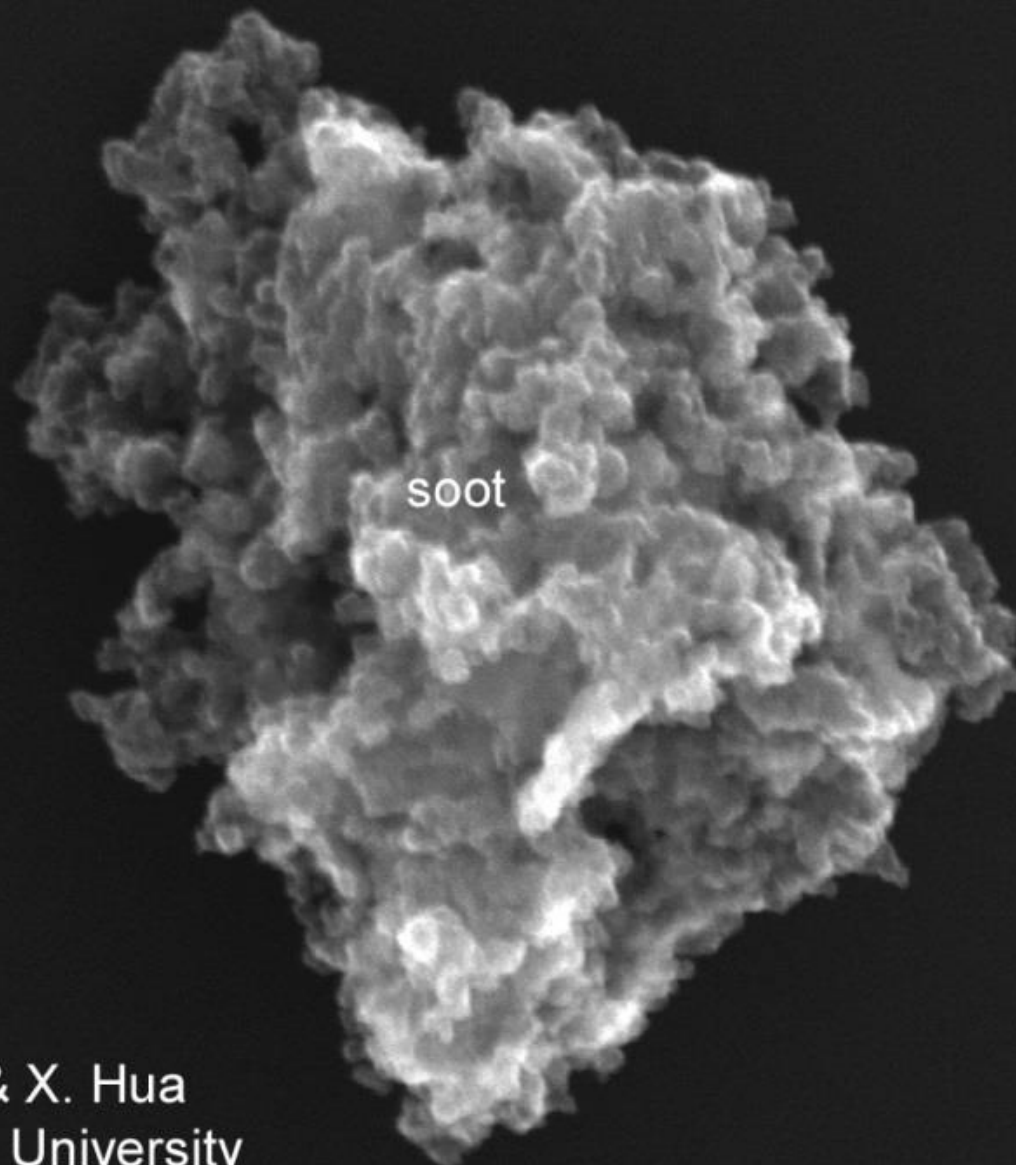
J. Anderson & X. Hua, Arizona State University

15.0kV 13.4mm x40.0k SE(U) 1/12/12 14:20

1.00um



IT-RF8-GNI 12:51:31-12:51:38  
7/22/11 330m

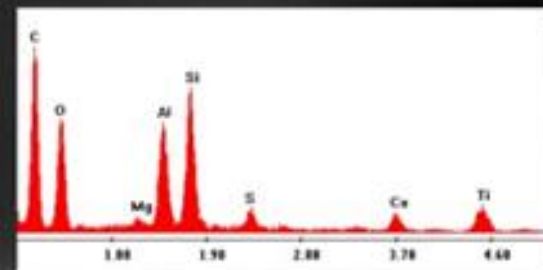
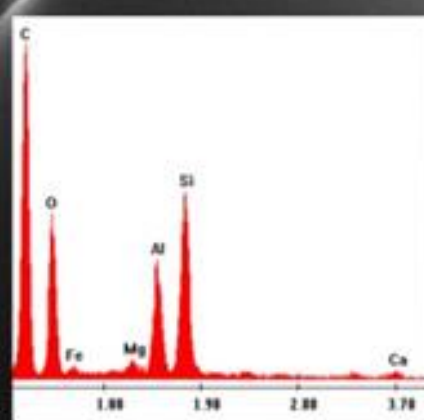


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Arizona State University

15.0kV 13.4mm x35.0k SE(U) 1/12/12 14:40

1.00um

IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'



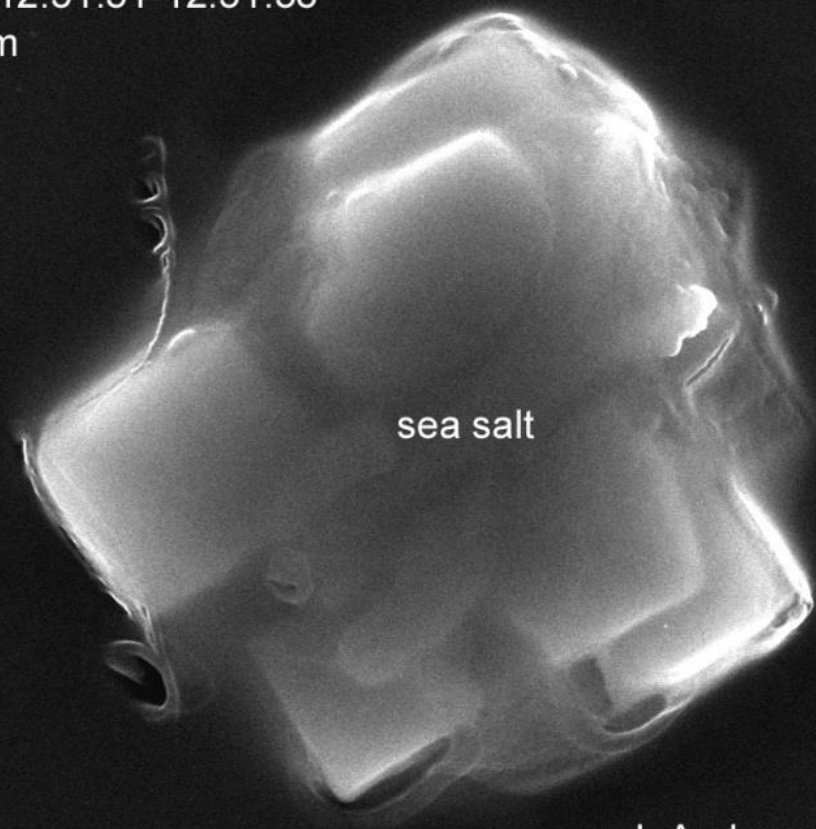
J. Anderson and X. Hua, Arizona State University

10.0kV 13.4mm x35.0k SE(U) 6/13/12 15:55

1.00um



IT-RF8-GNI 12:51:31-12:51:38  
7/22/11 330m

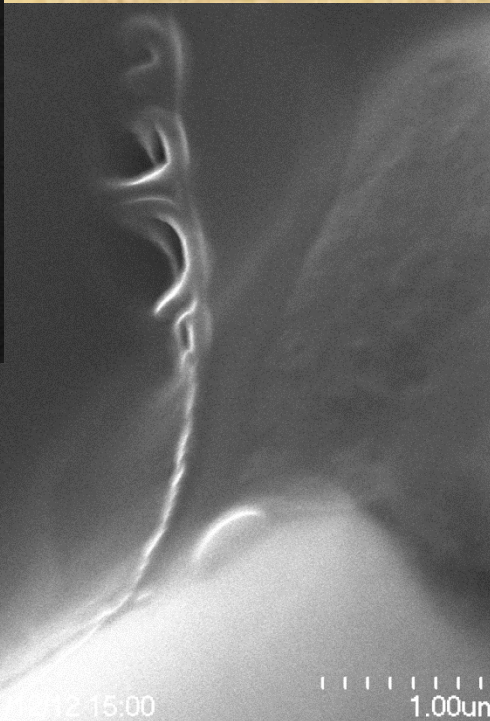


sea salt

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Arizona State University

5.00um

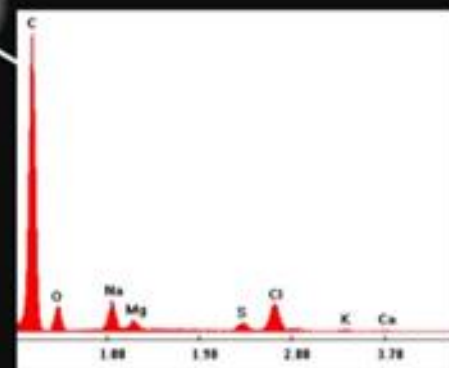
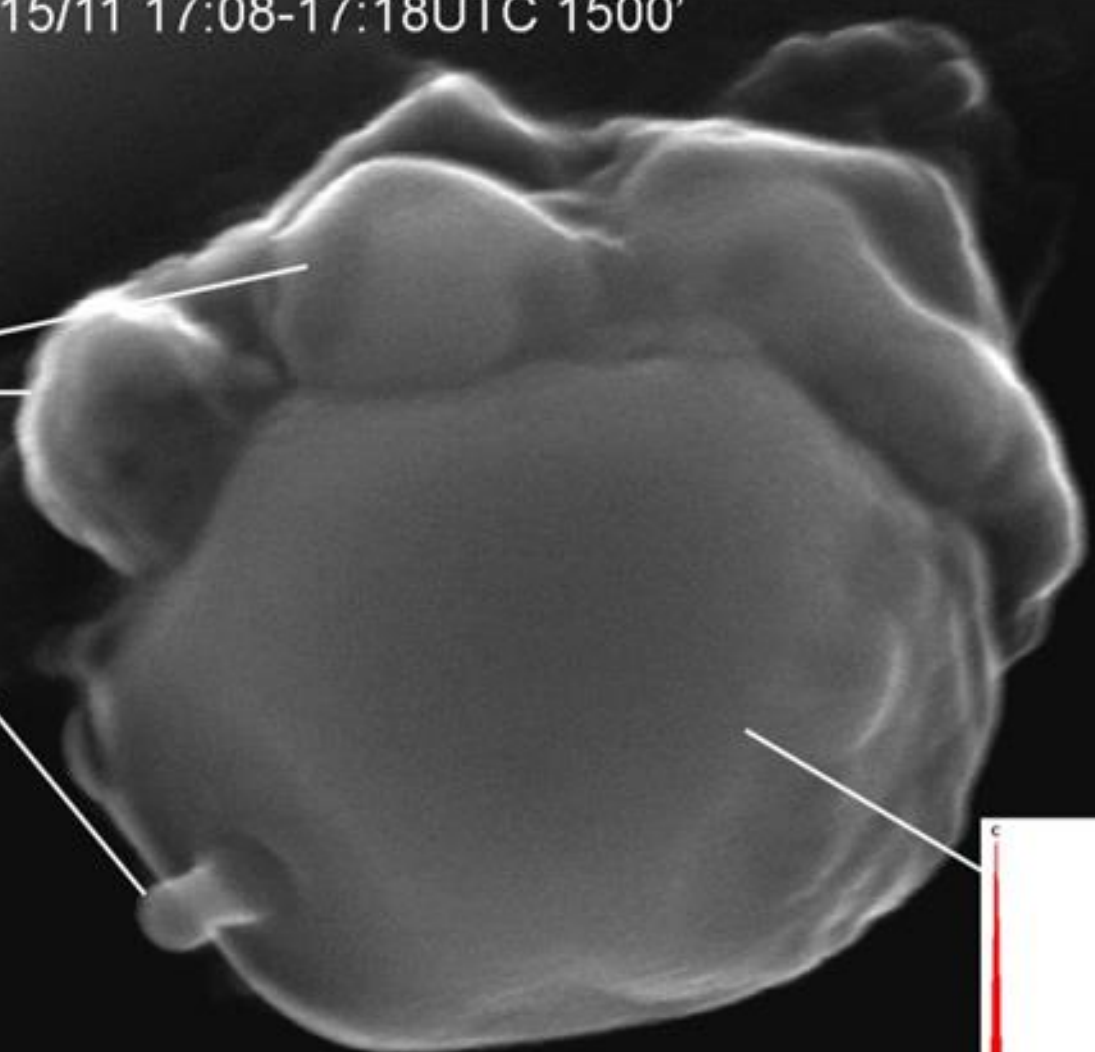
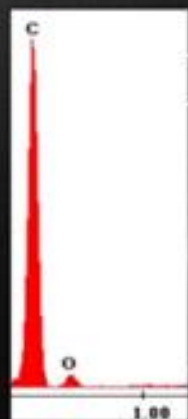
15.0kV 13.4mm x8.02k SE(U) 1/12/12 14:54



15.0kV 13.4mm x30.0k SE(U) 1/12/12 15:00

1.00um

IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'



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10.0kV 13.4mm x60.1k SE(U) 6/13/12 14:56

500nm

IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'

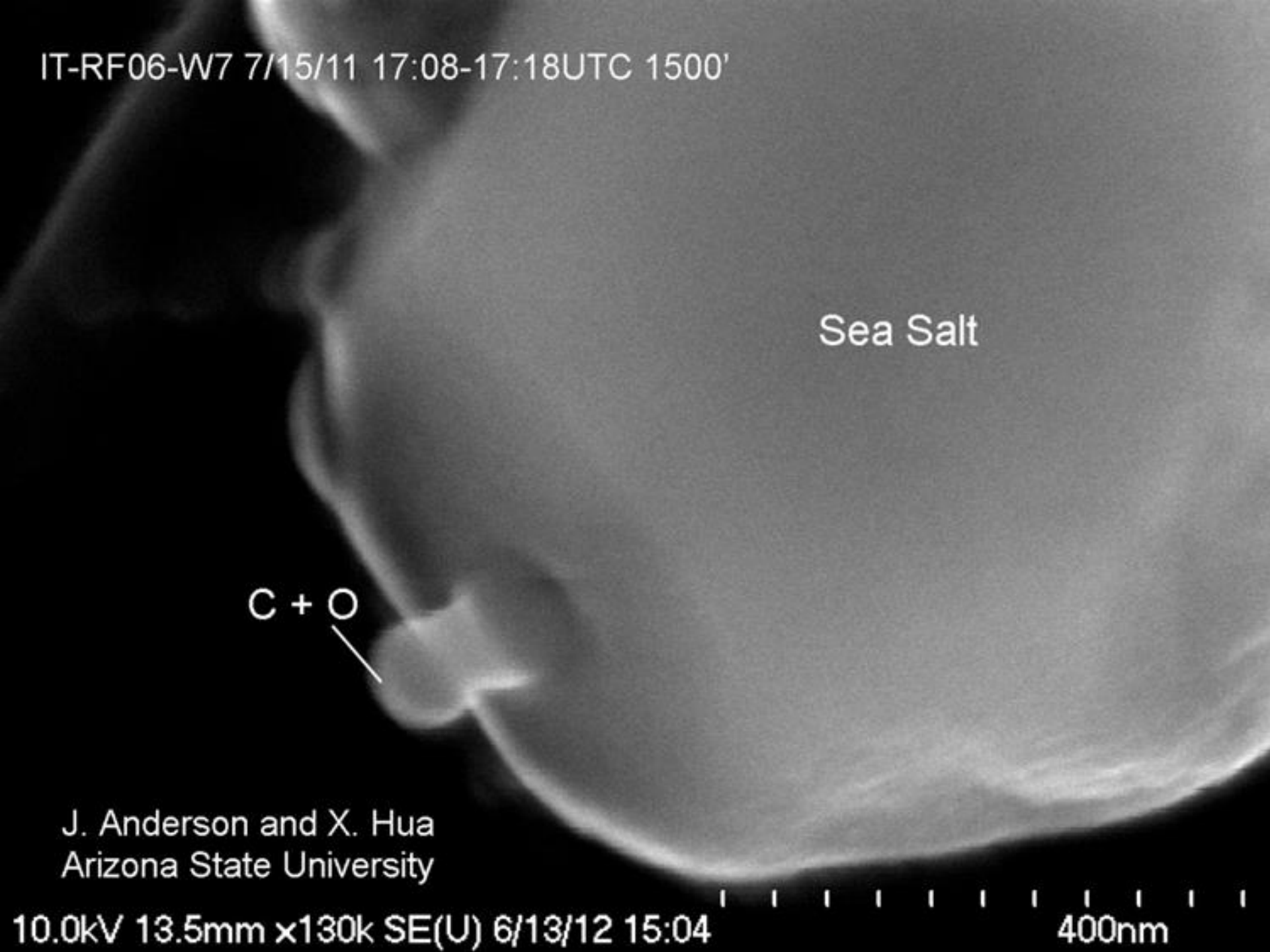
Sea Salt

C + O

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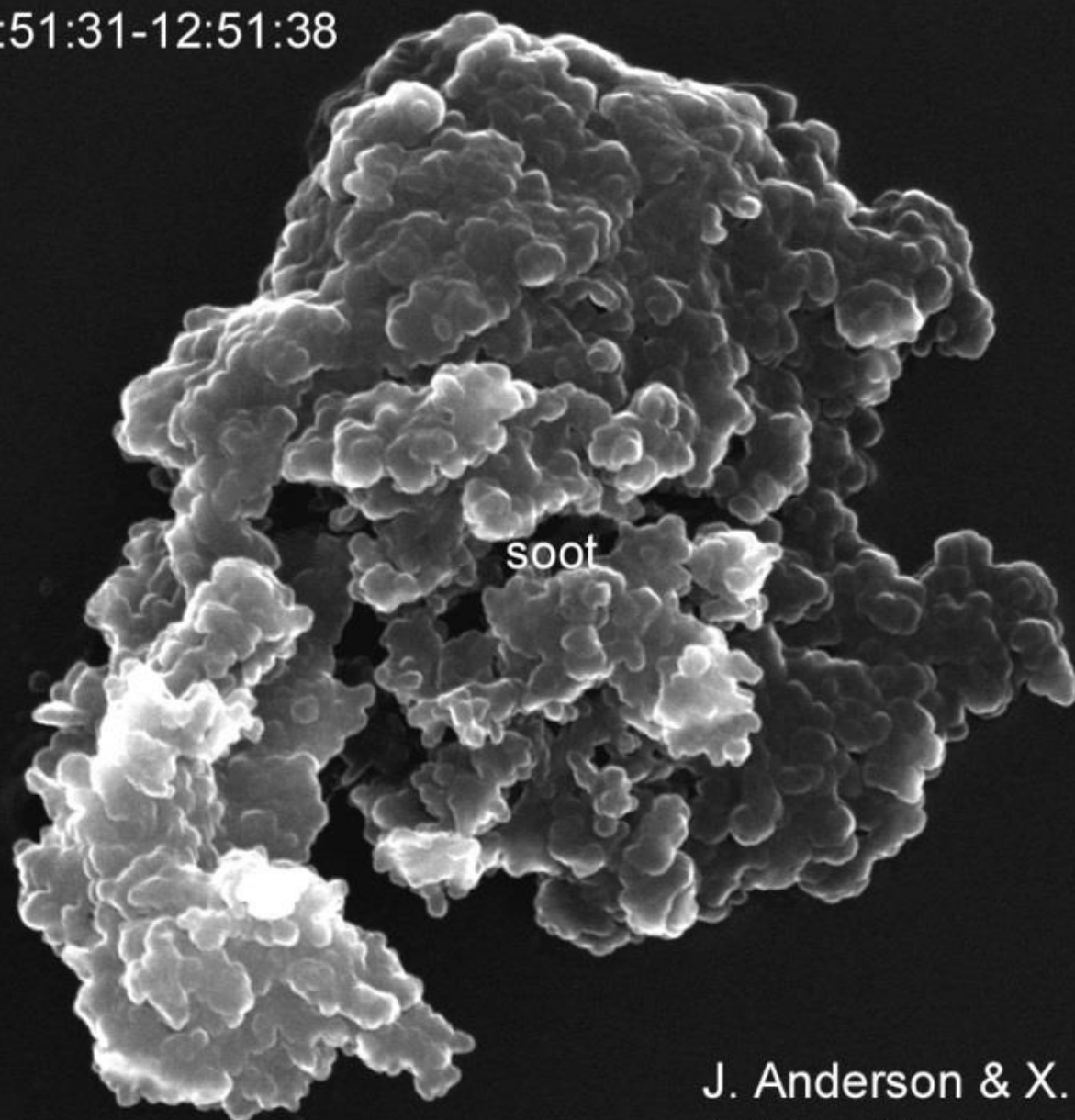
10.0kV 13.5mm x130k SE(U) 6/13/12 15:04

400nm





IT-RF8-GNI 12:51:31-12:51:38  
7/22/11 330m

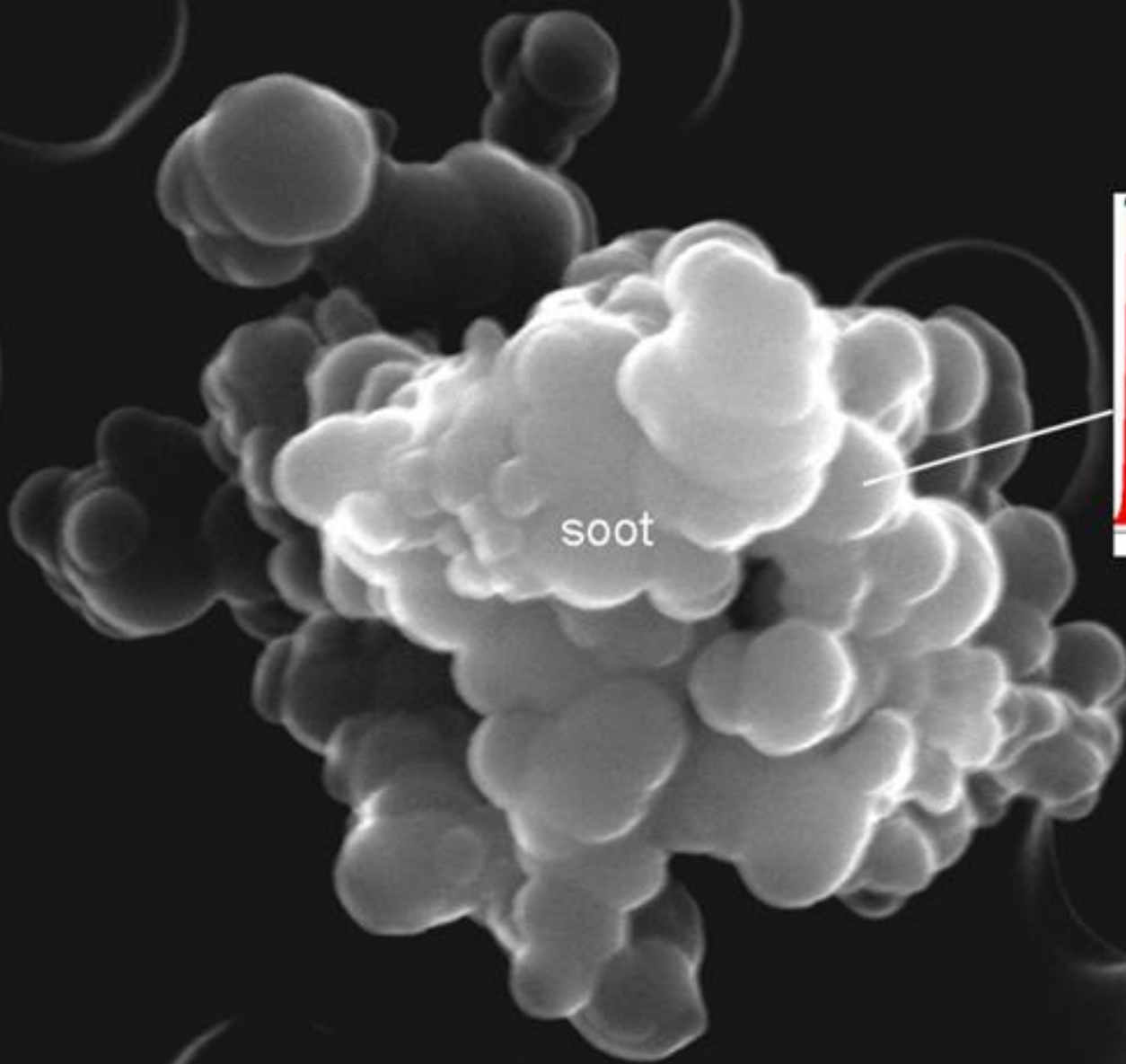


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Arizona State University

15.0kV 13.4mm x18.0k SE(U) 1/12/12 15:59

3.00um

IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'



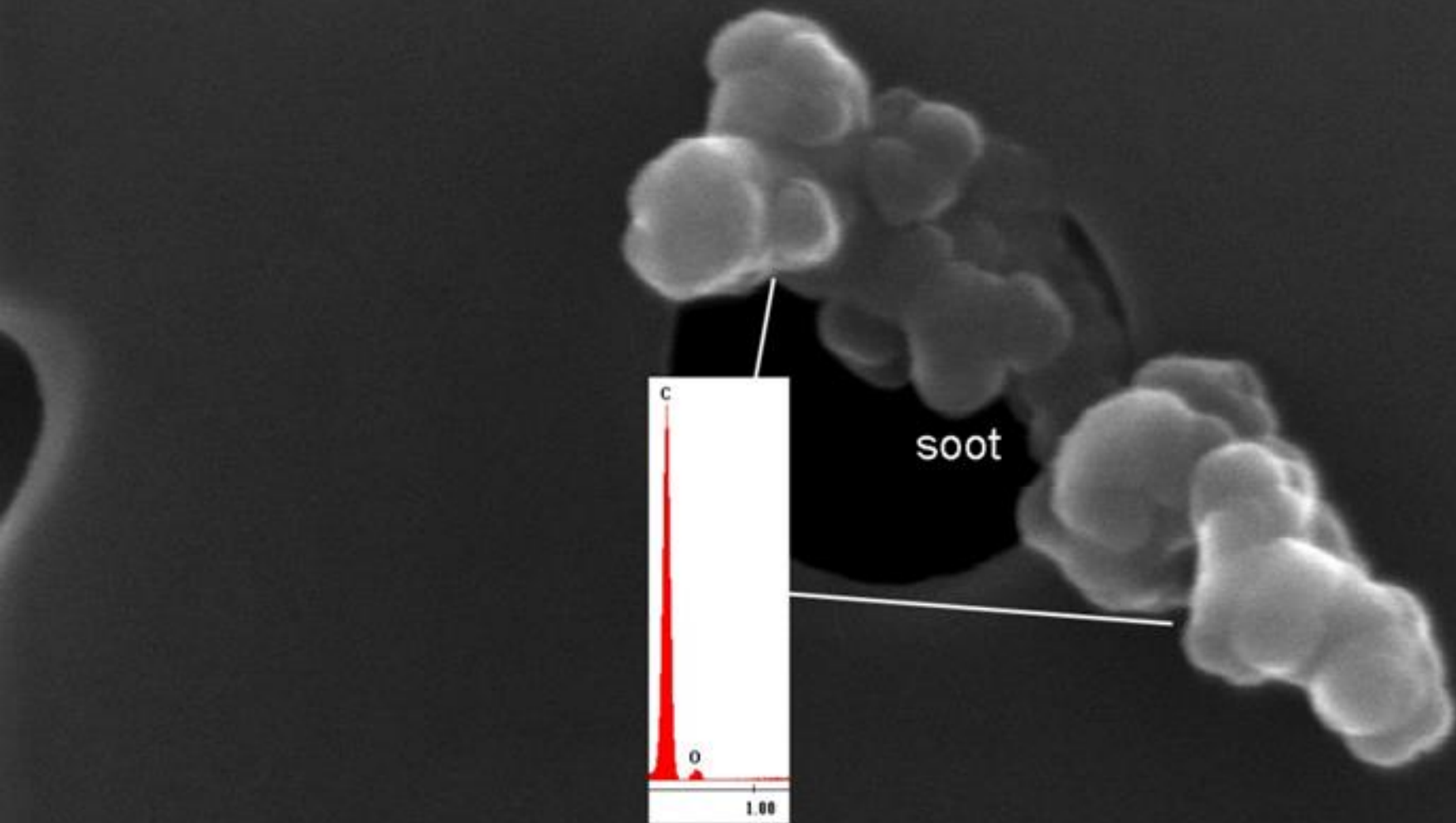
soot



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10.0kV 13.5mm x40.0k SE(U) 6/13/12 14:32





IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'

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10.0kV 13.4mm x80.2k SE(U) 6/13/12 15:22

500nm



IT-RF06-W7 7/15/11 17:08-17:18UTC 1500'

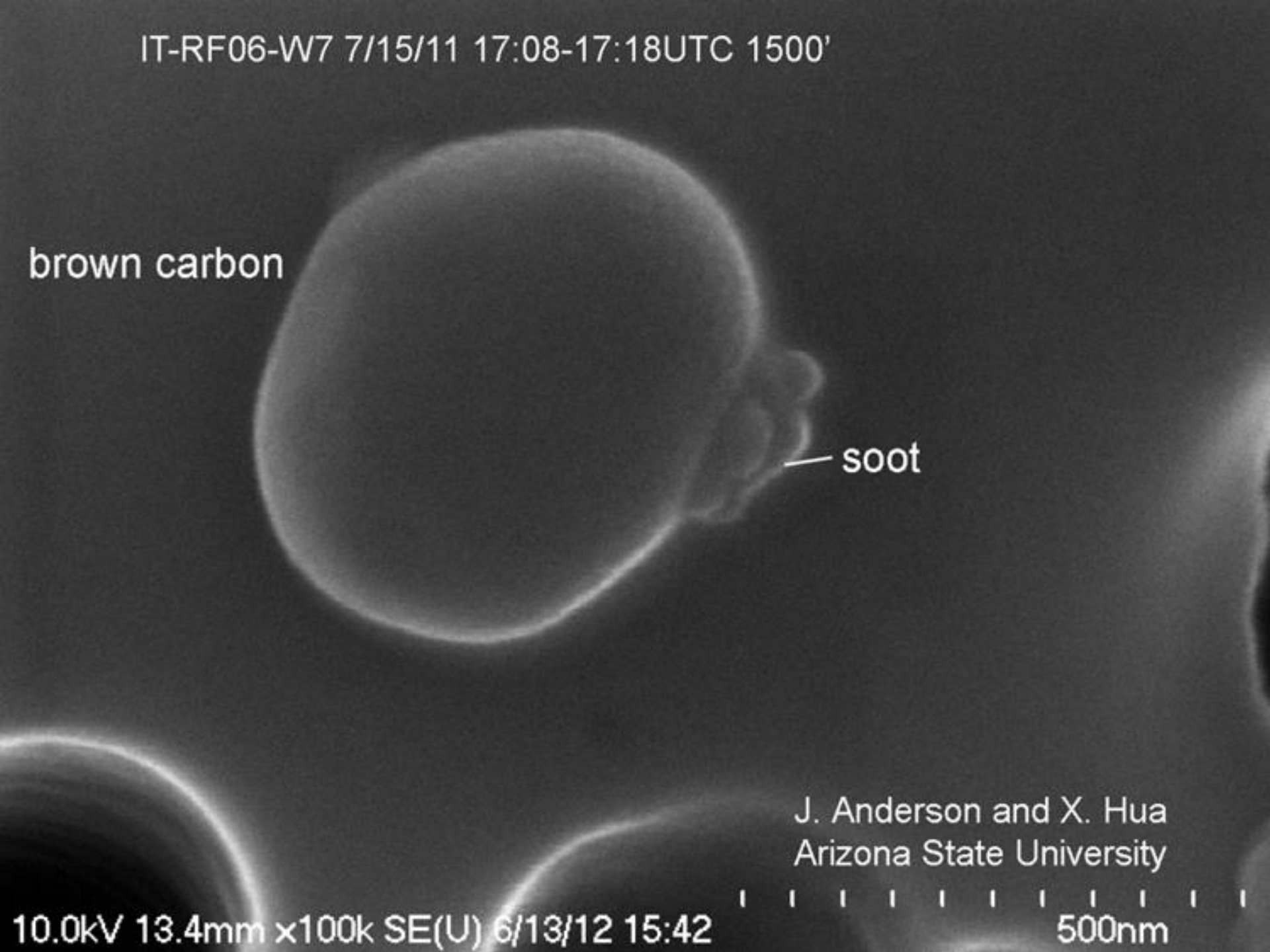
brown carbon

soot

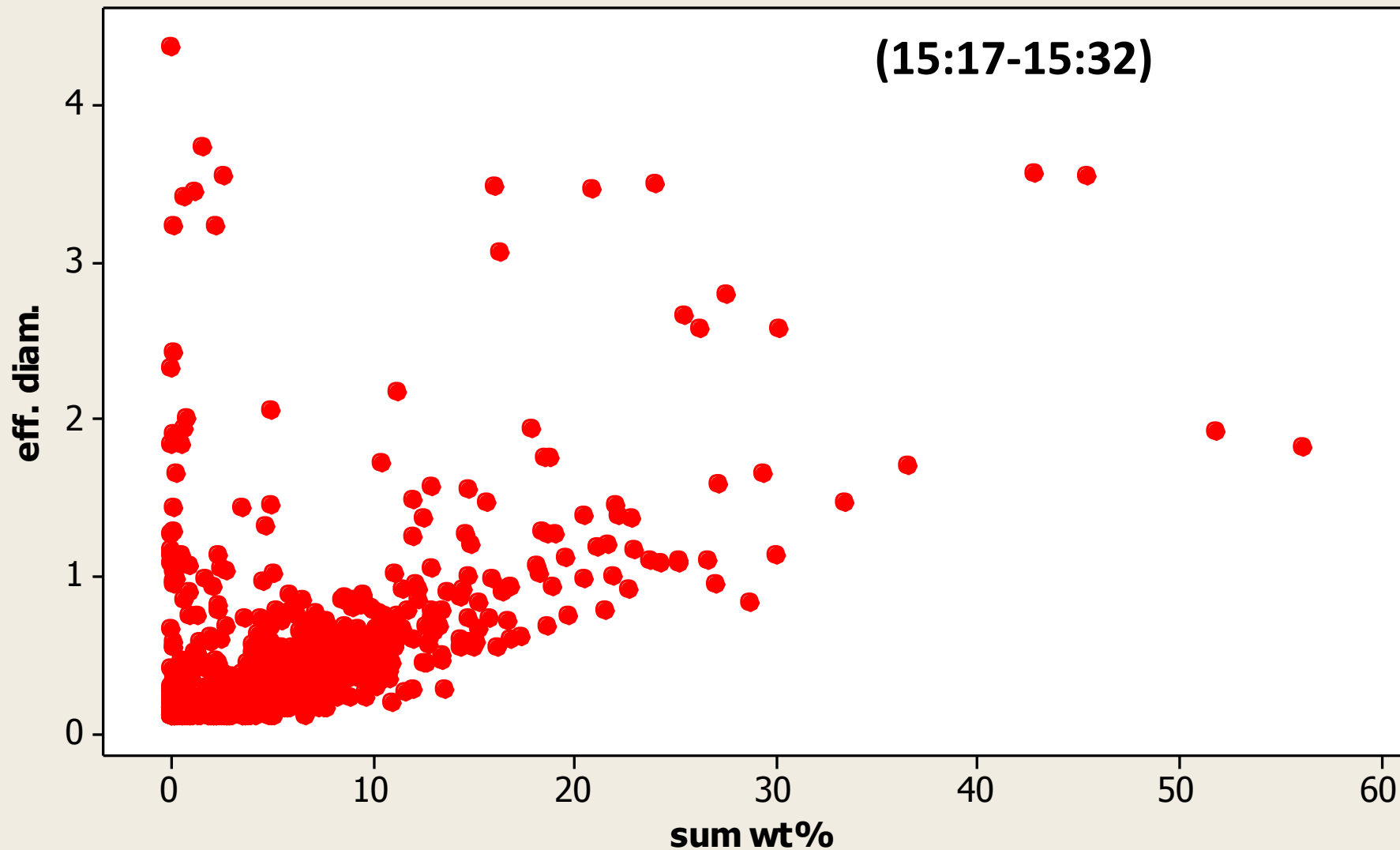
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Arizona State University

10.0kV 13.4mm x100k SE(U) 6/13/12 15:42

500nm



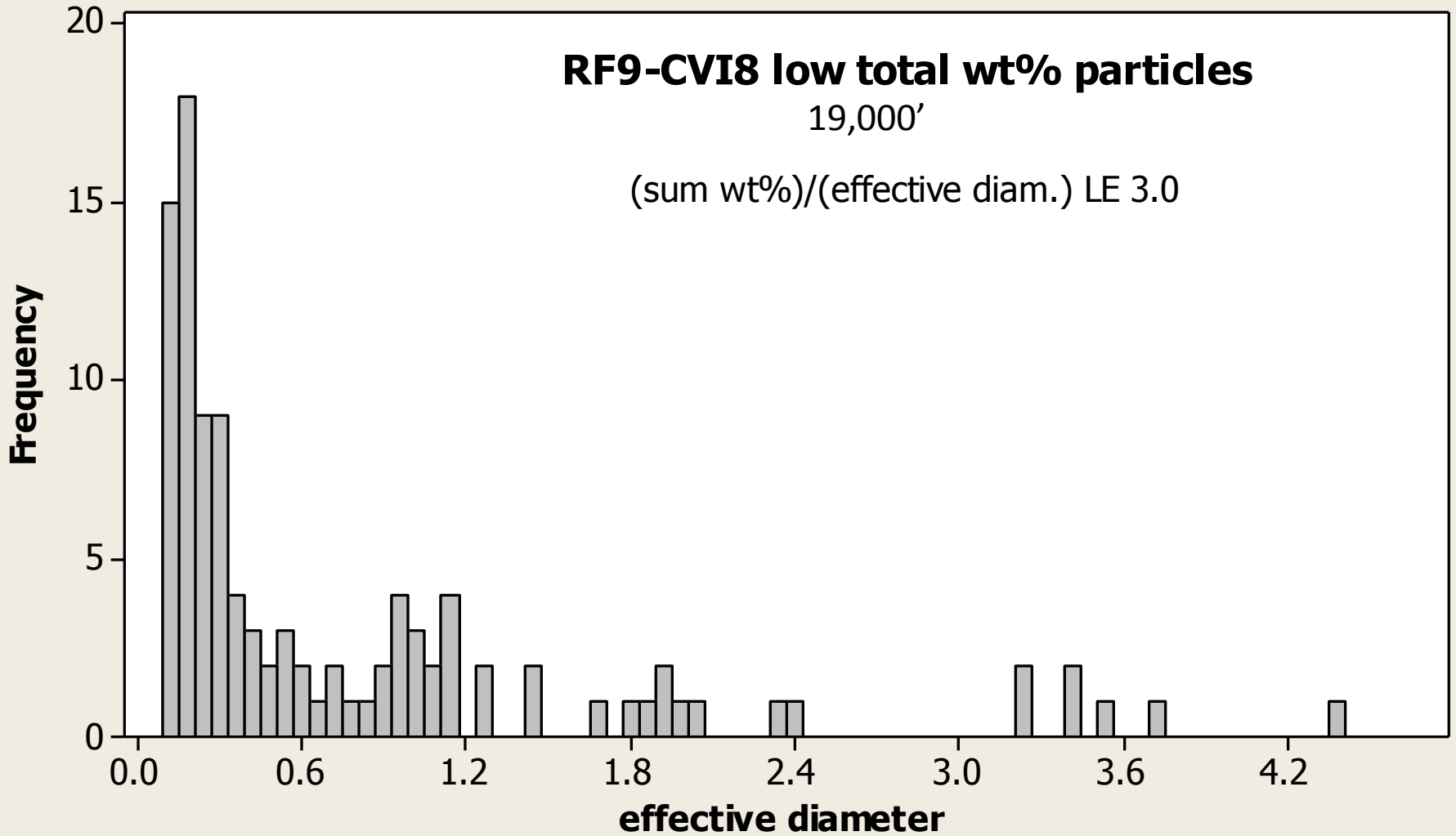
**RF9-CVI8 effective diam. vs sum wt%, 15:54:40-15:58:40, 5850m**



# RF9-CVI8 low total wt% particles

19,000'

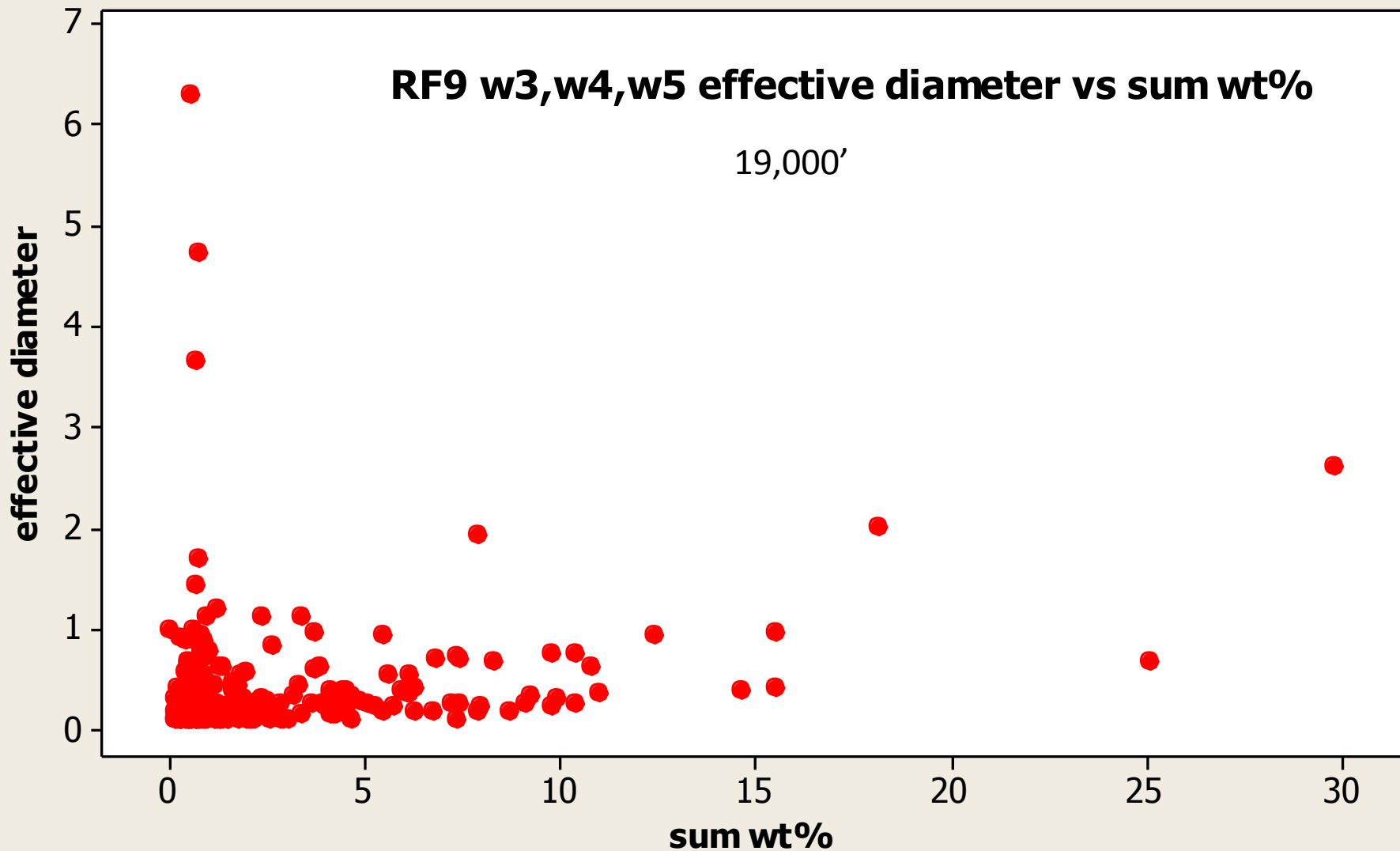
(sum wt%)/(effective diam.) LE 3.0





**RF9 w3,w4,w5 effective diameter vs sum wt%**

19,000'



## Copper artifact issue in CVI samples

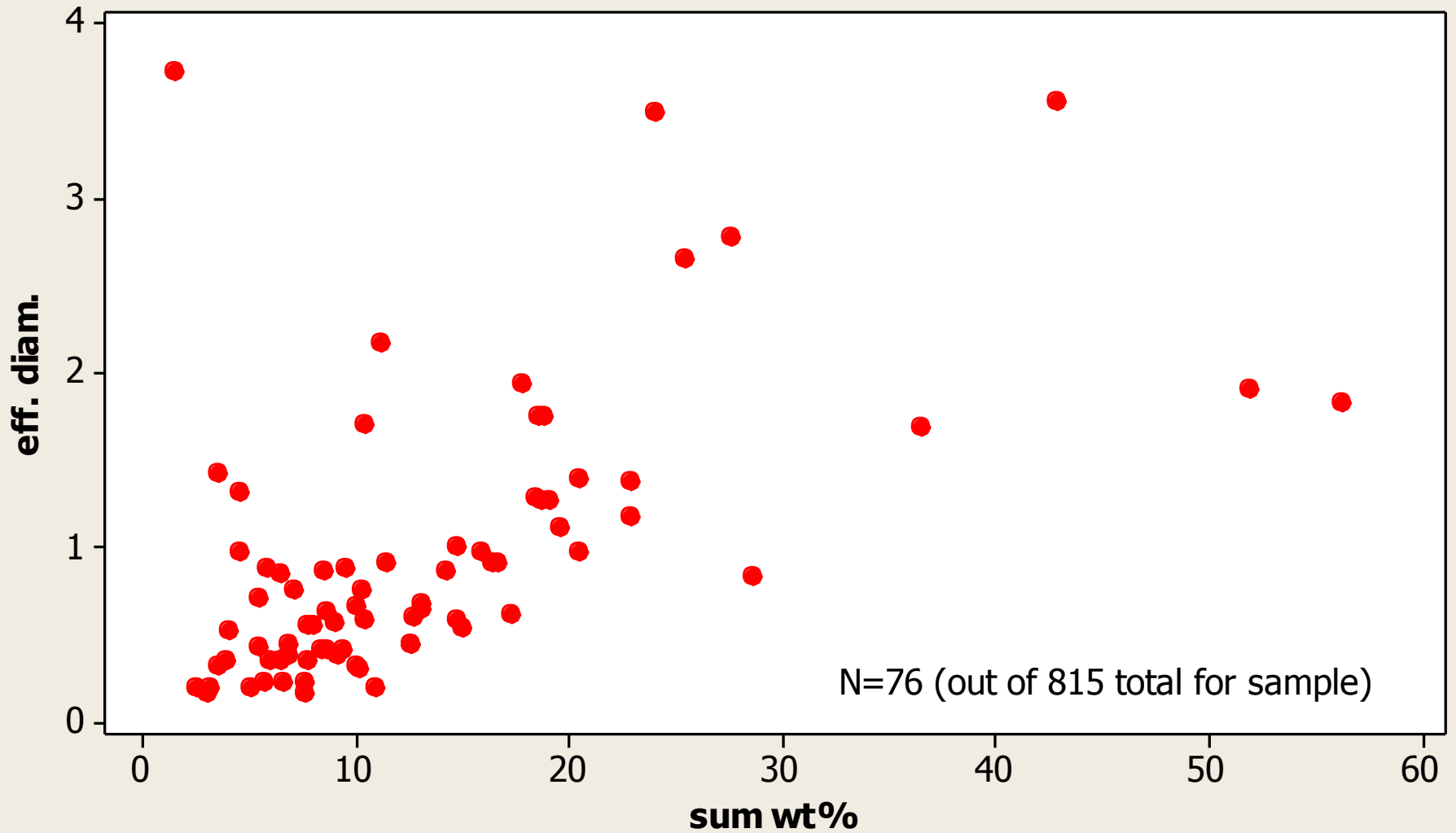
- Ice particle samples tend to have brass (Cu-Zn) associated with a fraction of the sea salt and silicate residual particles
- Some liquid droplet samples have Cu associated with a fraction of the sea salt residual particles (some with Zn, most without)
- Some liquid droplet samples have very few Cu artifacts
- Ambient samples have very few or no Cu-bearing particles

Ti-bearing particles in CVI and ambient samples seem to be mostly rutile (or its polymorphs)

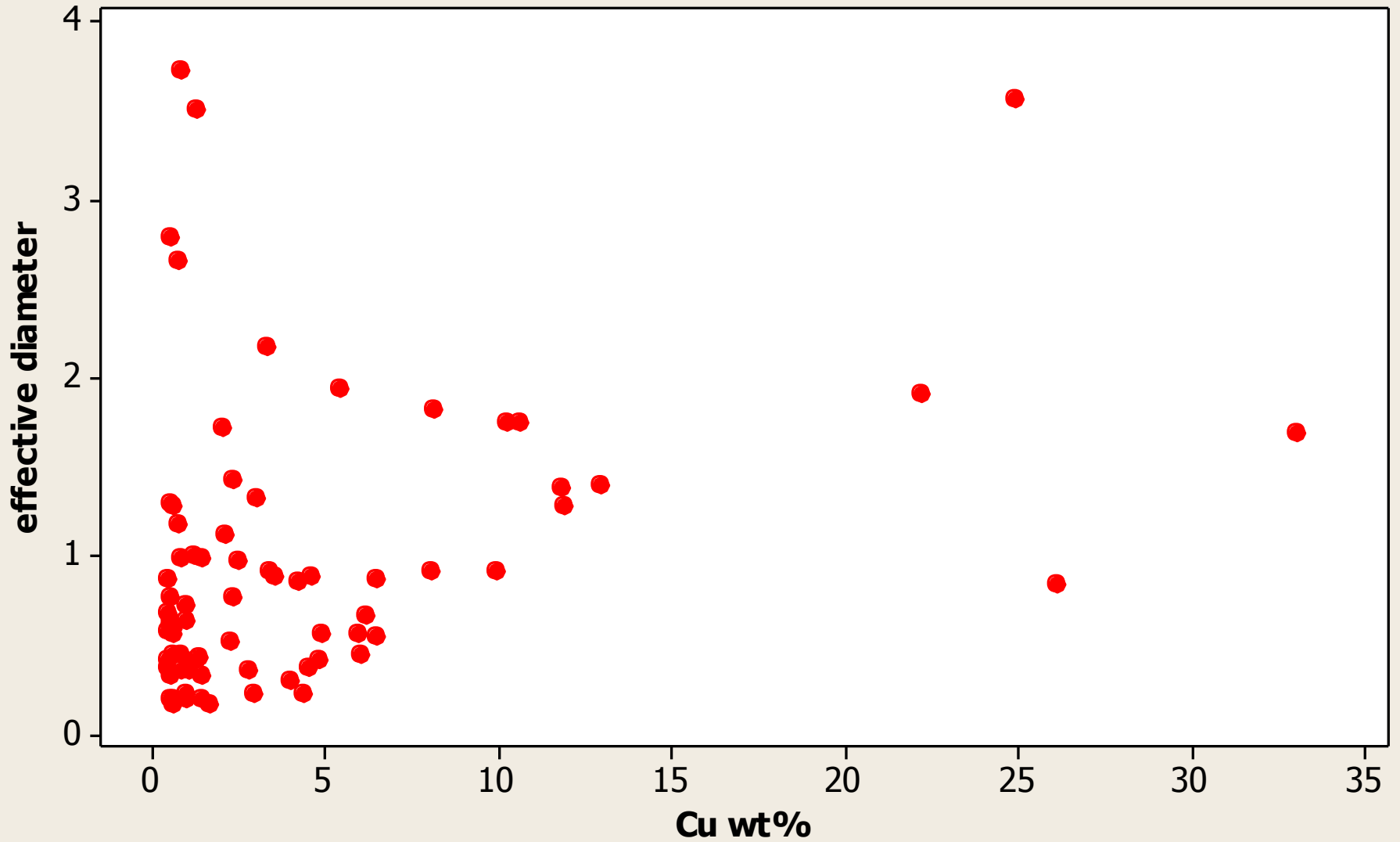
No Zr-bearing particles in samples CVI and ambient samples discussed here



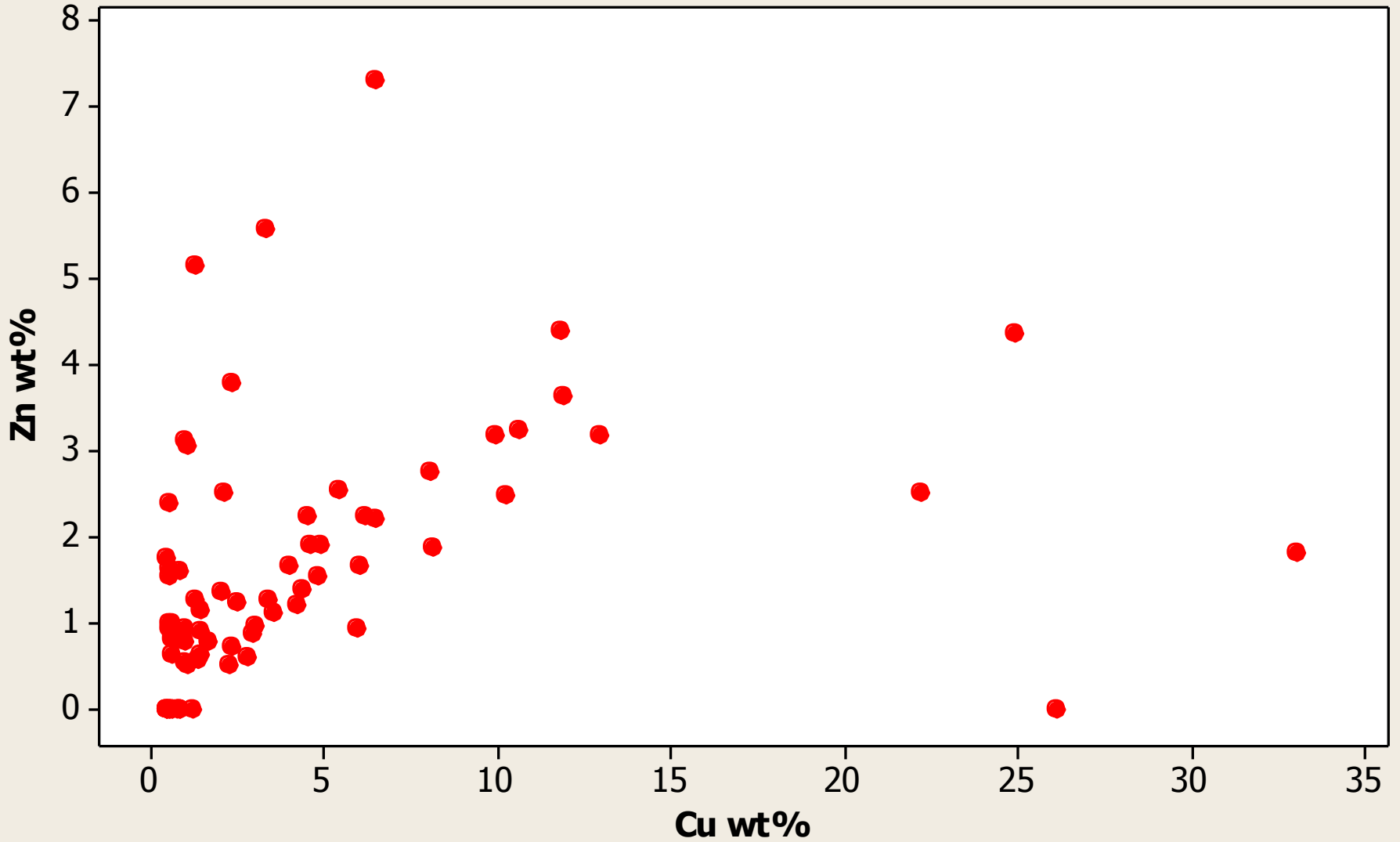
# effective diameter vs total wt%, Cu GE 0.5, RF9-8CVI



**effective diameter vs. Cu wt%, Cu GE 0.5, RF9-8CVI**

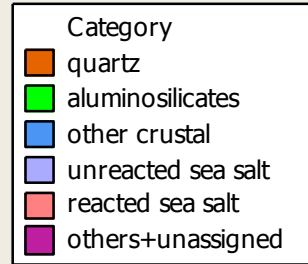
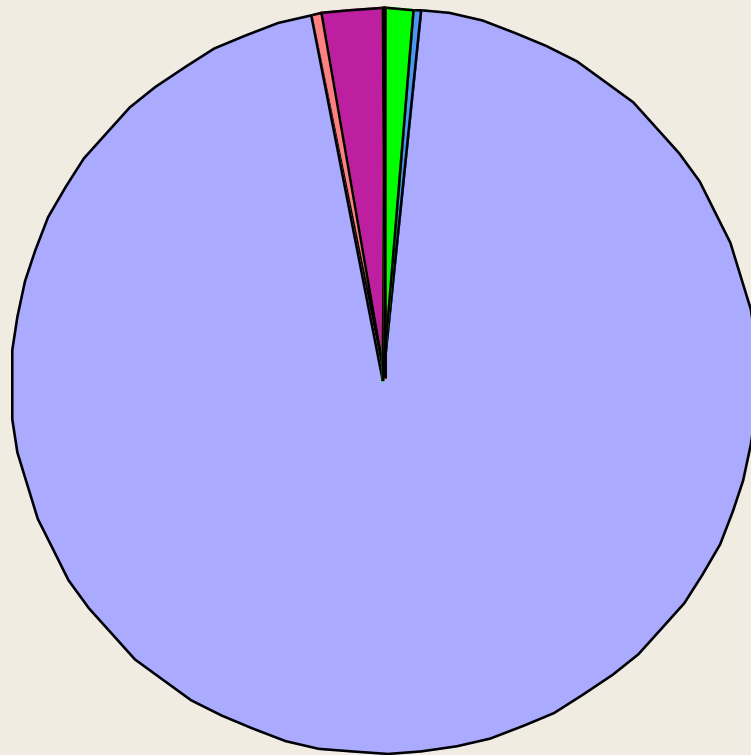


### Zn vs. Cu wt%, Cu GE 0.5, RF9-8CVI





**RF06 CVI-6 15,000'**

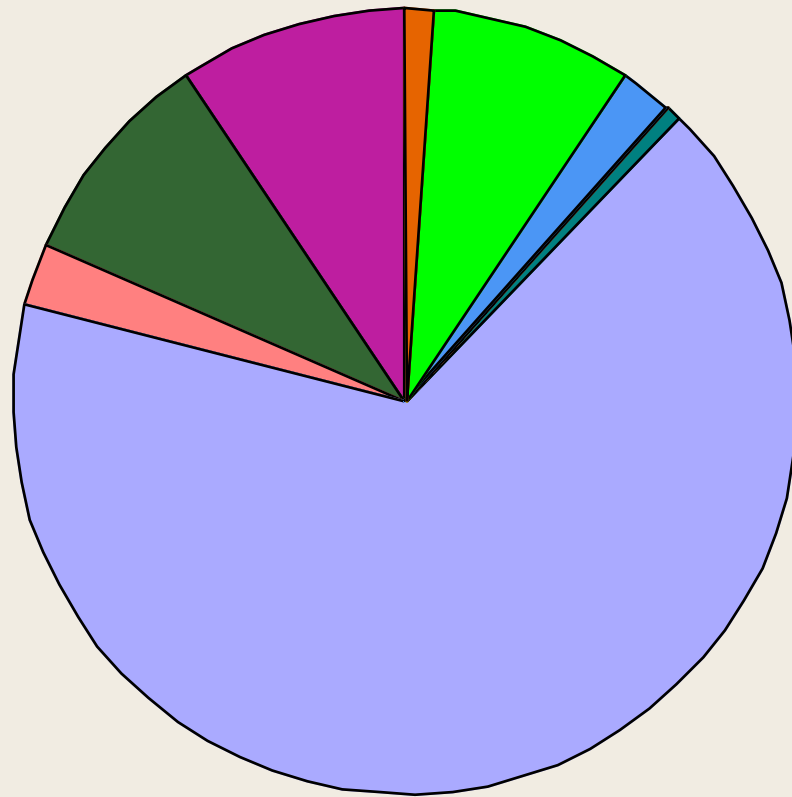


Cu	Zn
0.61	0.00
0.64	0.00
0.57	0.00
0.57	1.38
1.01	0.79
1.37	0.00
3.27	0.00
0.67	0.48
0.68	0.00
0.53	0.49
0.64	0.61
6.85	0.00
14.09	5.02
0.55	0.00
0.71	0.00

**7/15/11 15:09:22-15:14**

**Cu GE 0.5, 15 particles out of 1000 total, 6 with Zn, associated with sea salt in all but one case**

# RF06 CVI-1, 2100' near cloud base

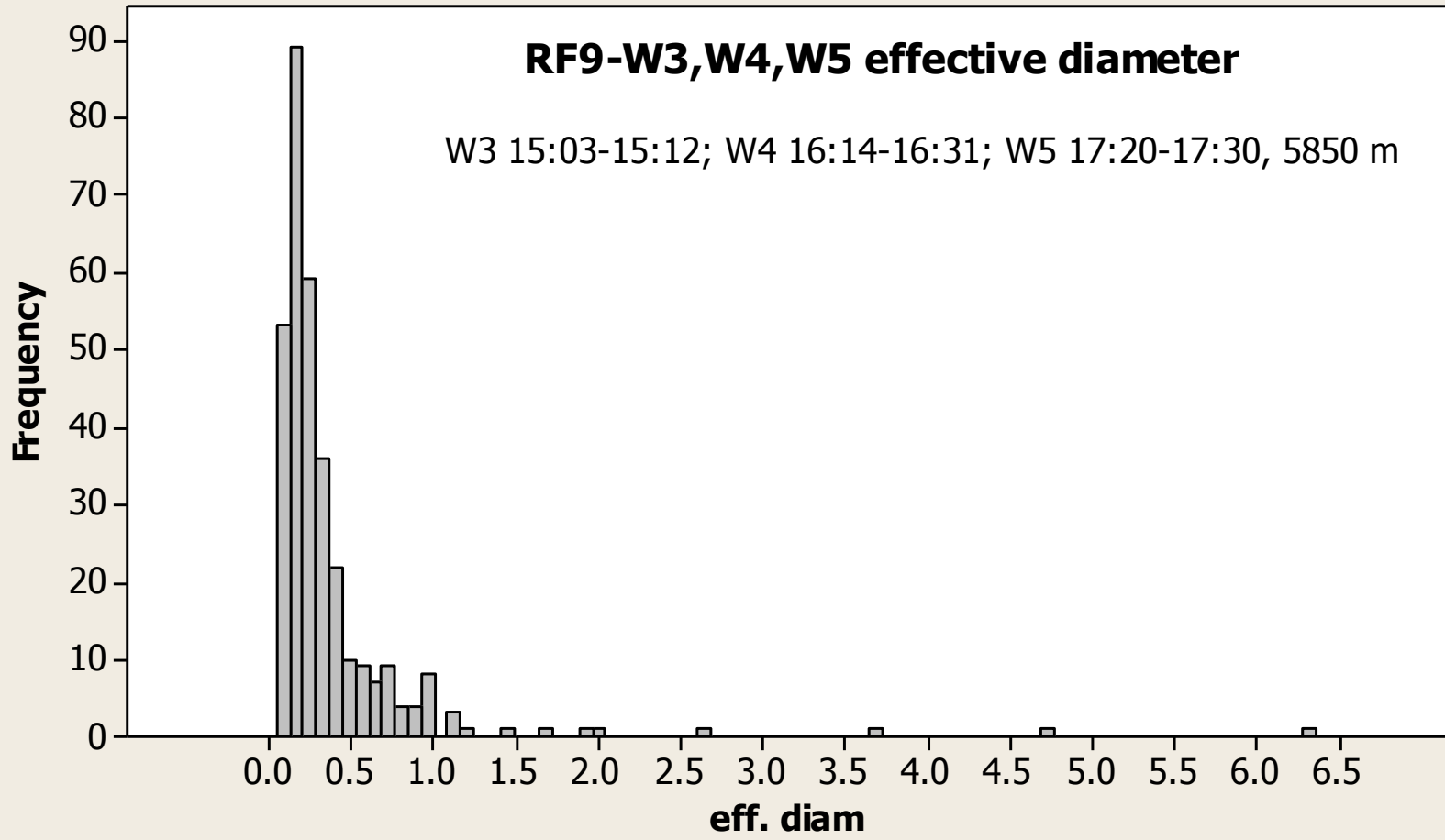


Category
quartz
aluminosilicates
other crustal
silicates+sulfates
silicates+sea salt
unreacted sea salt
reacted sea salt
sulfate
others+unassigned

Cu	Zn
0.52	0.00
0.70	0.00
0.55	0.00
1.57	1.83
0.99	0.00
0.59	0.00
1.17	0.00
0.93	0.00
0.57	0.00
0.72	0.00
1.61	0.00
1.14	0.00
0.86	0.00
2.00	0.00
0.58	0.00
0.56	0.00
0.52	0.49
0.59	0.00
0.66	0.00
0.81	0.63
0.63	0.00
0.93	0.00
0.51	0.00
3.92	0.00
0.51	0.00
1.25	0.00
2.51	0.88
0.62	0.00
0.57	0.00
2.47	0.76
1.16	0.00
0.53	0.90

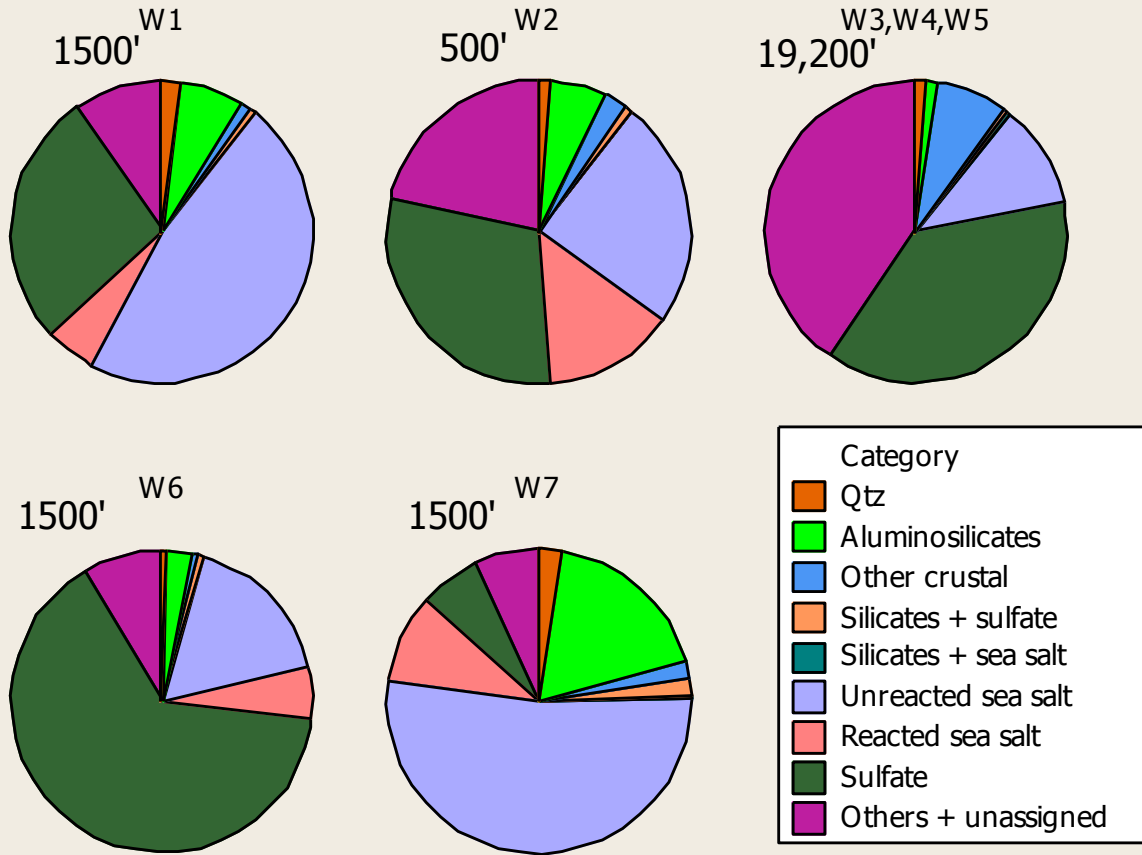
**7/15/11 13:19:15-13:23:40**

**Cu GE 0.5, 32 particles out of 1000 total, 6 with Zn  
most associated with sea salt**





# ICE-T RF9 ambient samples, July 23, 2011



W3, W4 and W5 combined (19,200') have zero Cu-bearing particles