Individual-particle studies of cloud droplet residues and ambient aerosols in RICO: the effect of particle size, composition, surface properties, and mixing state on trade wind cumuli.

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Objectives

● Are giant (dry radius > 1 μm) and ultragiant nuclei (dry radius > 10 μm) present in the aerosol, are they responsible for the onset of precipitation, and what are their compositions and mixing states?

● For smaller hygroscopic inorganic nuclei (sea salt, reacted sea salt, sulfate), what are the relationships with regard to preferential activation, and what are their compositions and mixing states?

● During North African dust episodes, what effect does mineral dust have on cloud properties and precipitation? How important is aggregation or coating of dust with sulfate, nitrate, or other species?

● What evidence is there of aerosol aging and cloud processing (e.g., reacted sea salt)?

● Do other aerosol types such as elemental carbon and low-volatility organic species play a role in trade-wind cumulus cloud properties?

Analytical methods

- Automated scanning electron microscopy
- High-resolution SEM imaging with standard Field Emission SEM
- Transmission electron microscopy of submicron Particles

- Imaging under elevated RH with environmental Field Emission SEM

- Environmental TEM analysis of submicron particles under elevated RH

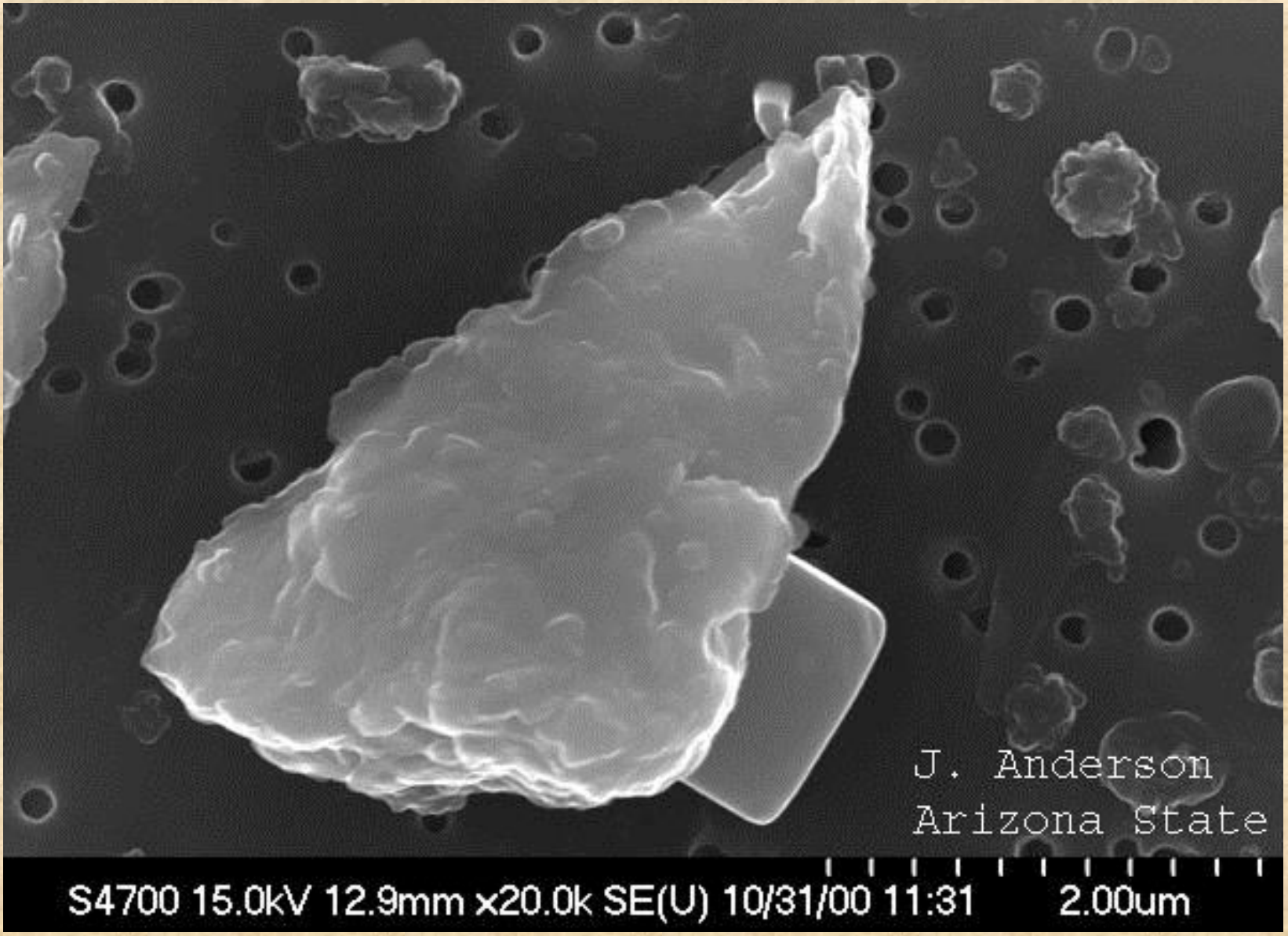
(3 different SEMs, 3 or 4 TEMs)

Inlets and sampling systems (all on C-130):

a. **Counterflow Virtual Impactor (Cindy Twohy), cloud droplet residues – single stage polycarbonate membrane filter for SEM, 3-stage micro-impactor with 3 mm grids for TEM.**

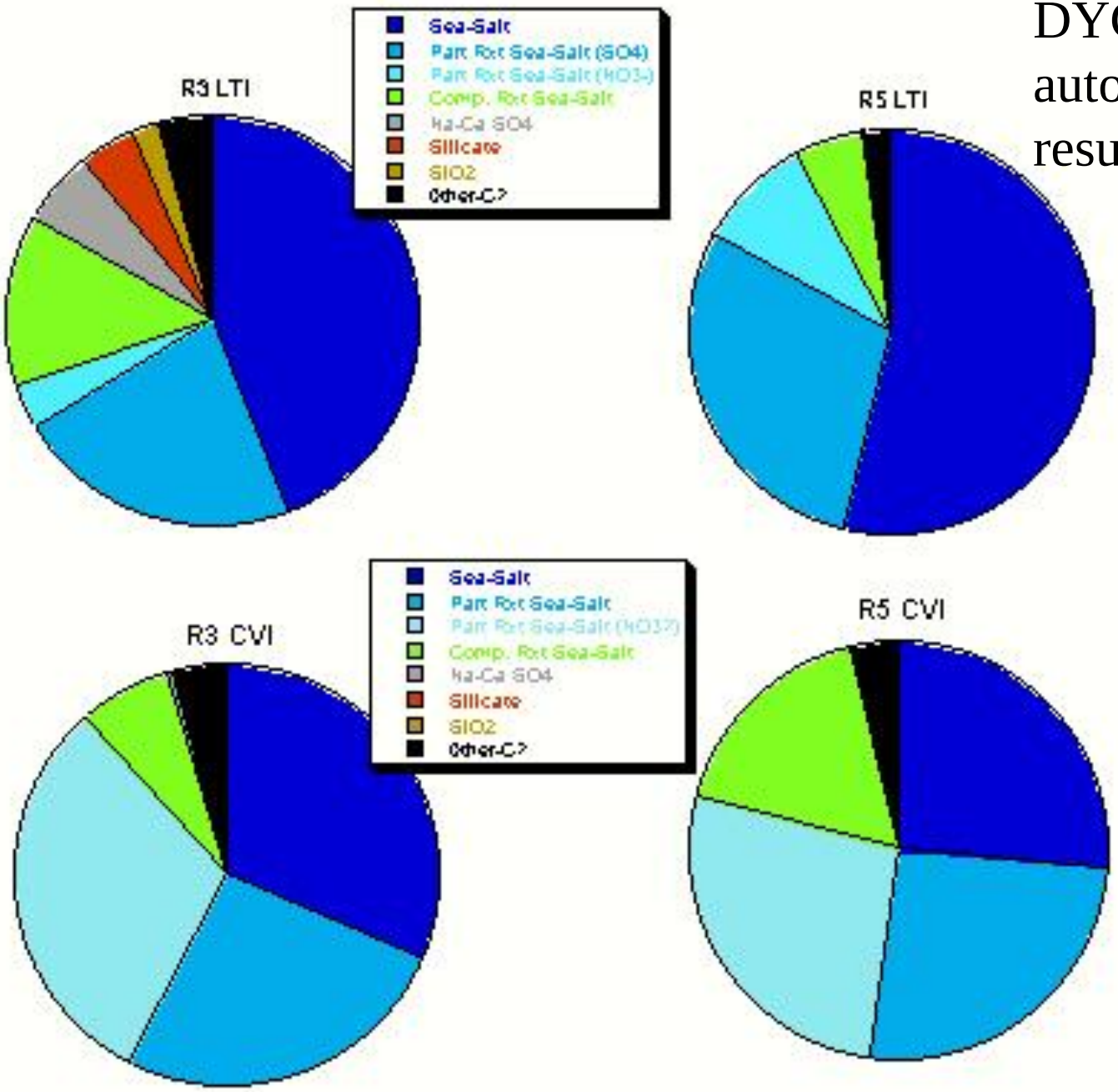
b. **Total Aerosol Sampler (TAS) – 90 mm polycarbonate membrane filter**

c. **Solid diffuser inlet (SDI) – 3-stage micro-impactor, interested in submicron ambient aerosol for TEM.**



Barbados, April 1992

DYCOMS II automated SEM results



(% by N; D_p>0.2 μm)

PELTI (July 2001, flying out of St. Croix)

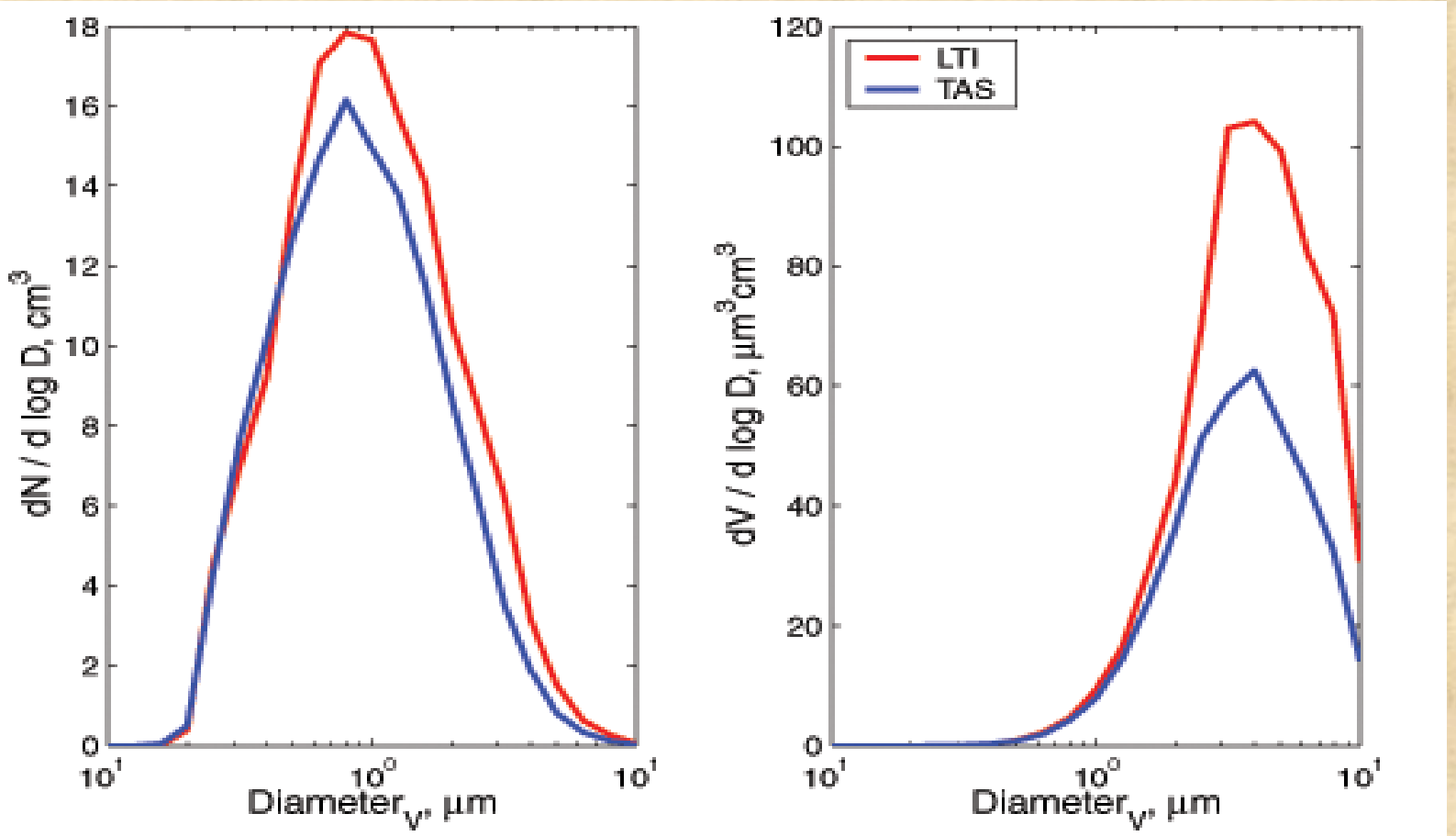
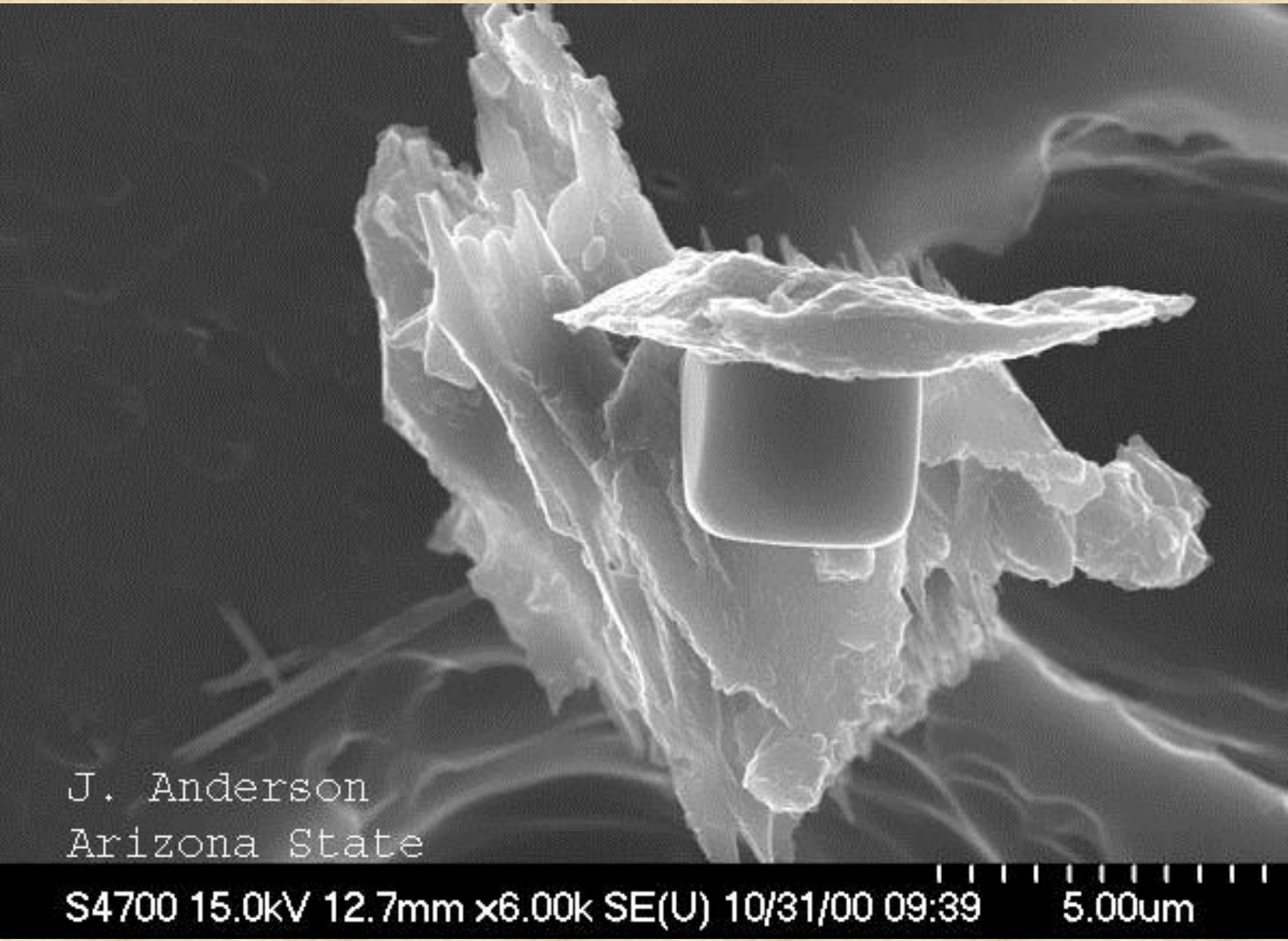
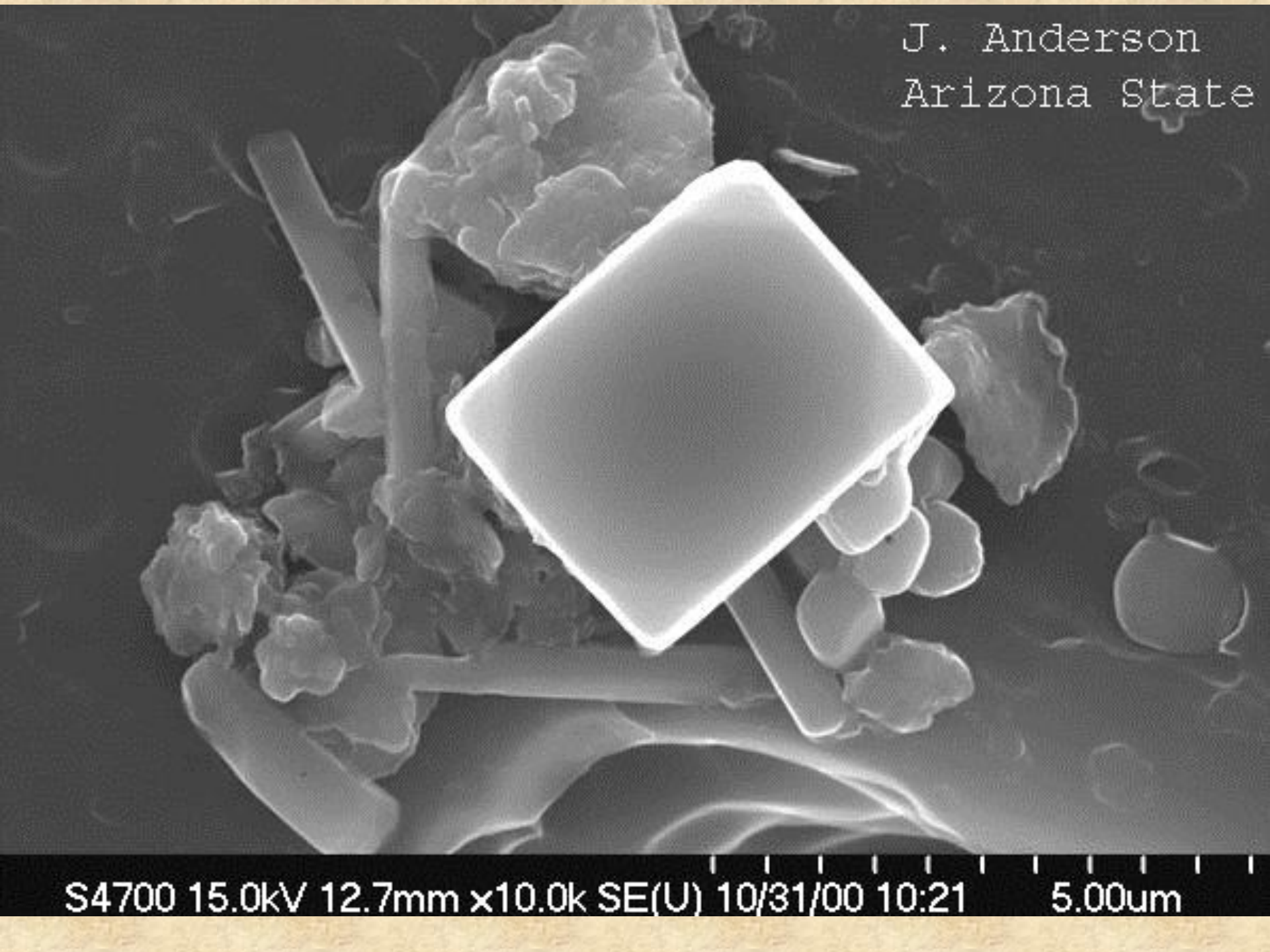


Figure 3.4.2 Size distributions via SEM for sample RF08-1553. The left panel is a number distribution, showing higher concentrations of supermicron particles behind the LTI than in TAS. The right panel demonstrates that the volume in the larger sizes is enhanced by as much as 75%. The (effective spherical) diameter is derived by multiplying the measured particle area by an assumed thickness equal to the minimum dimension to compute particle volume.


J. Anderson
Arizona State
S4700 15.0kV 12.7mm x6.00k SE(U) 10/31/00 09:39
5.00um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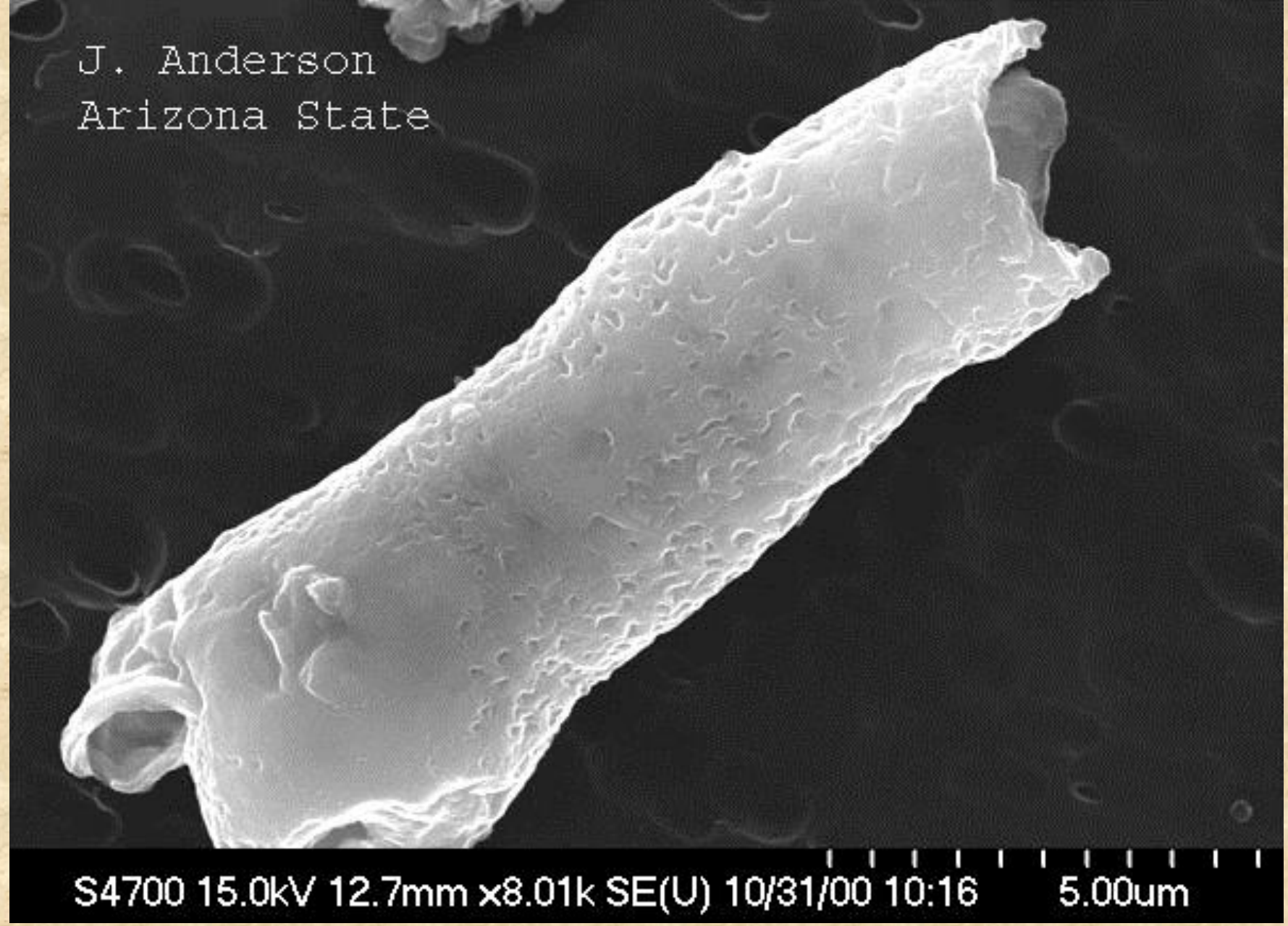
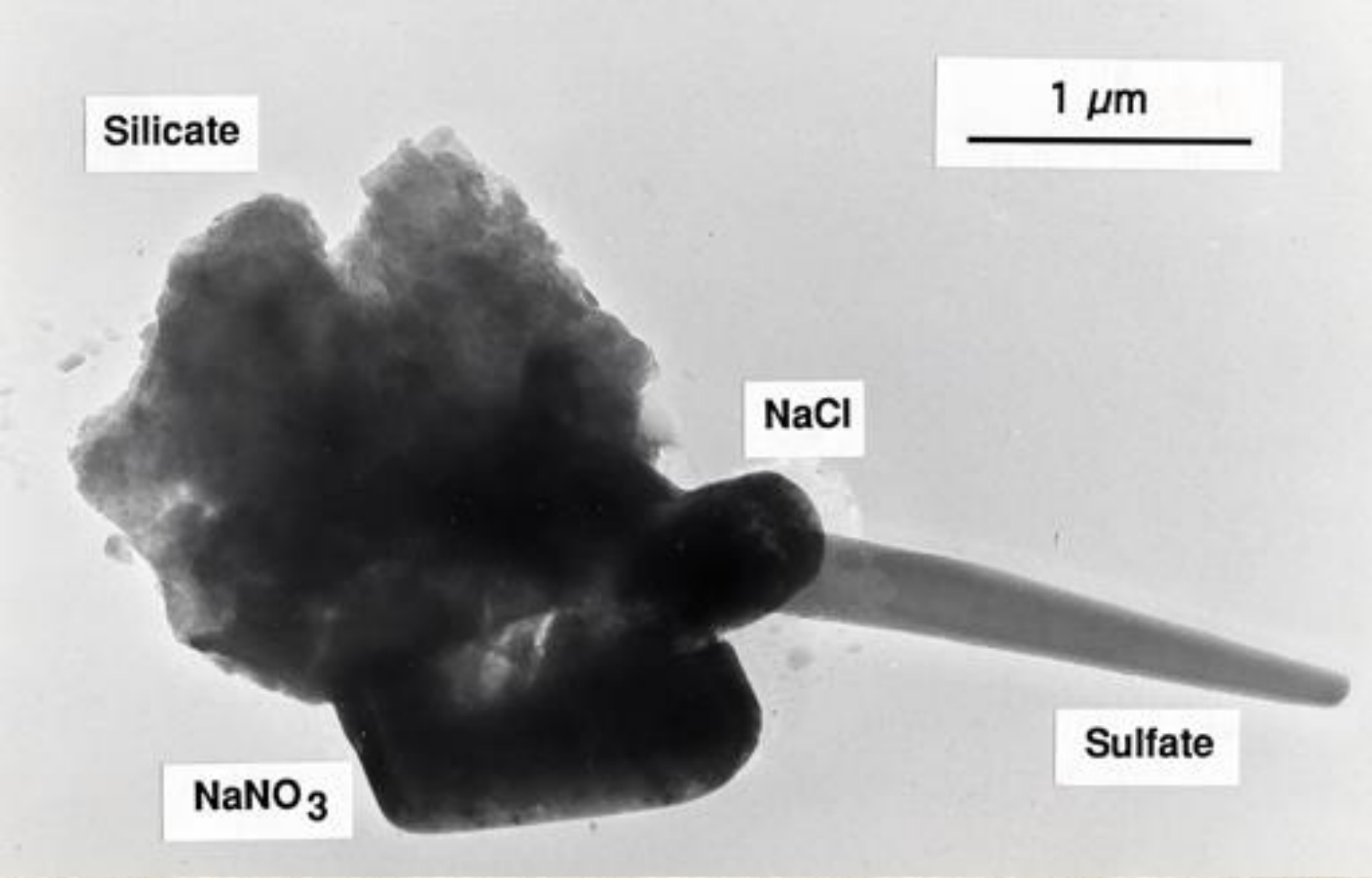
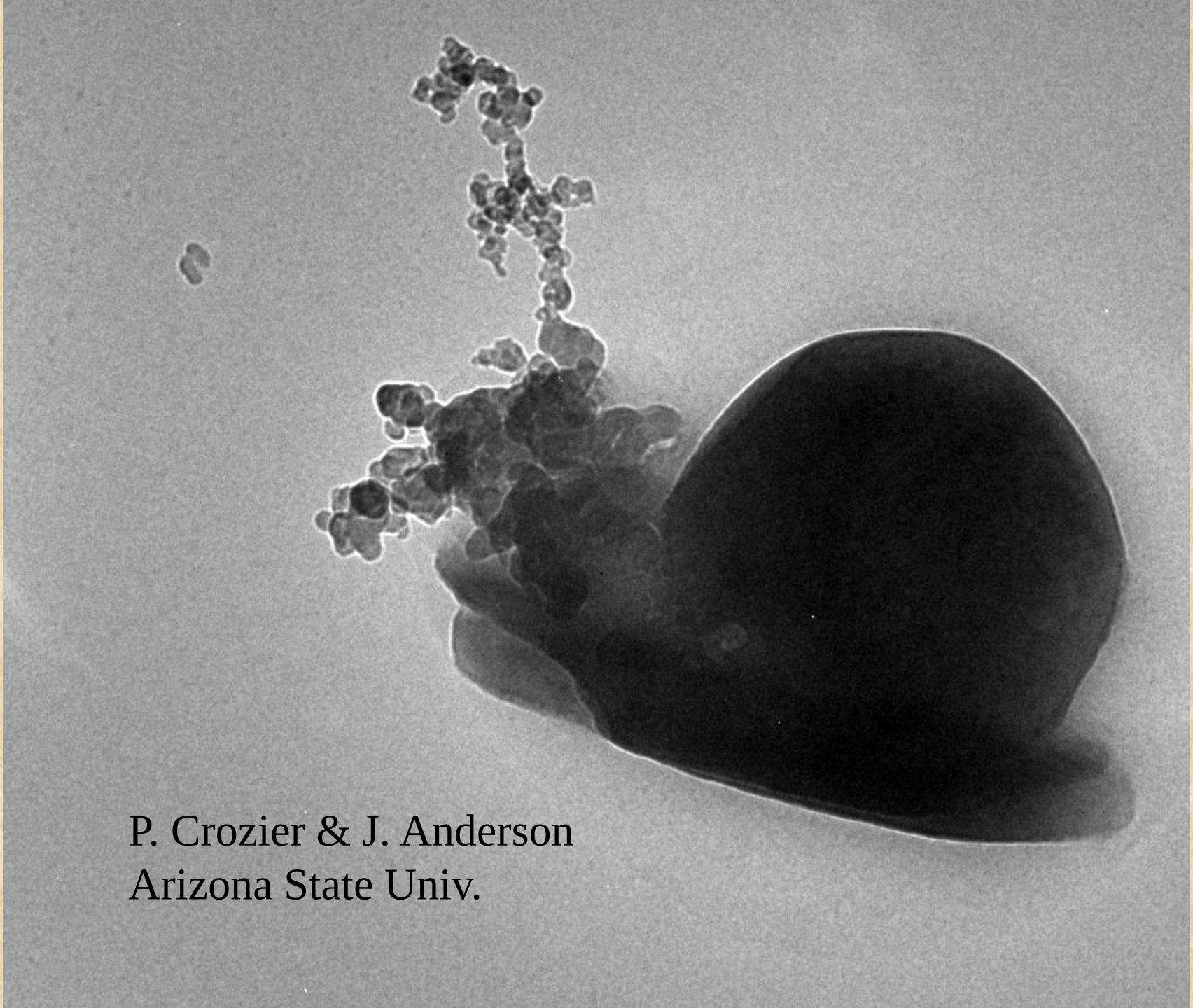


A fairly high percentage of particles > 10 microns can be biogenic in origin. (Barbados, July 1992)



Conventional TEM



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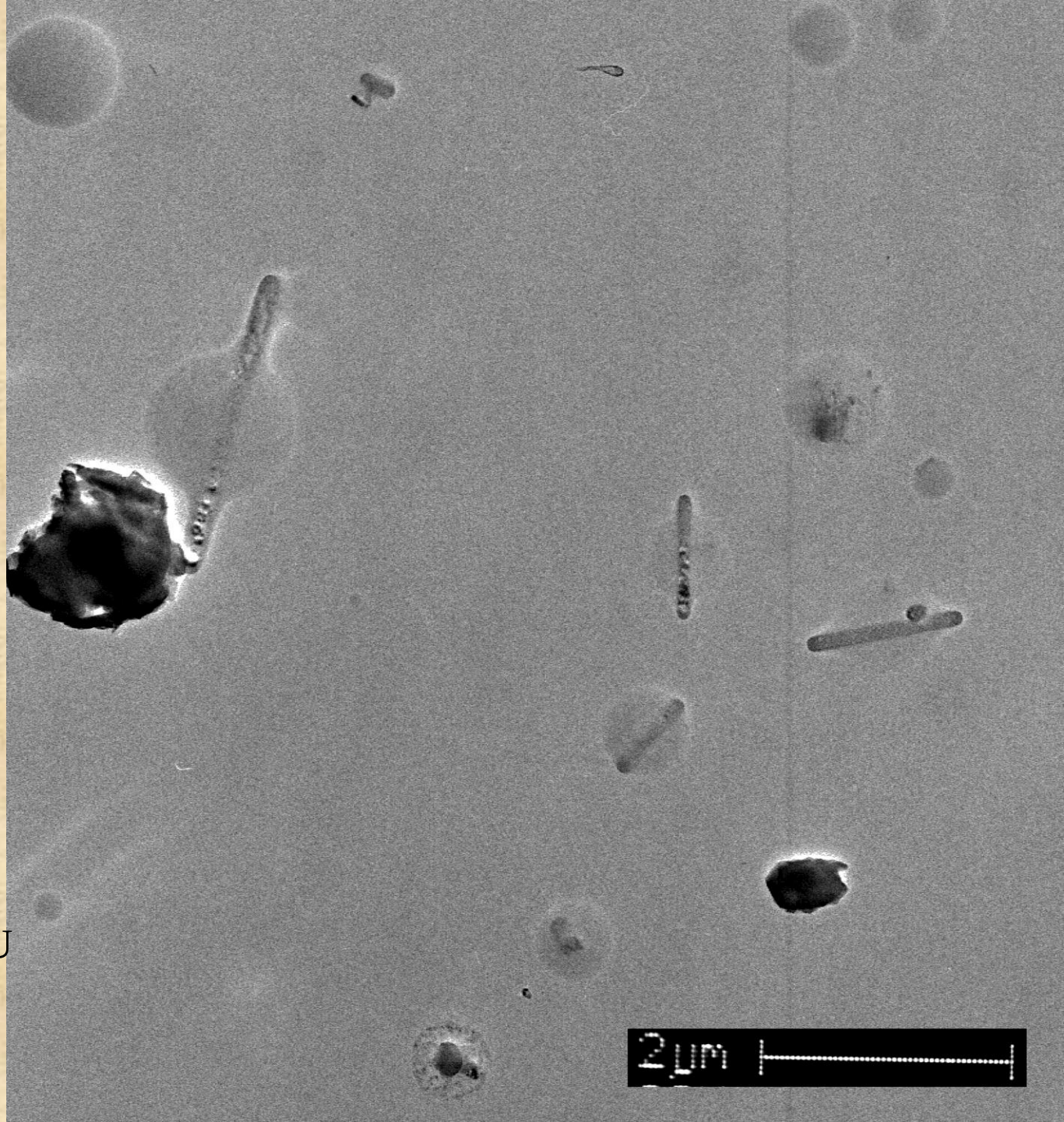
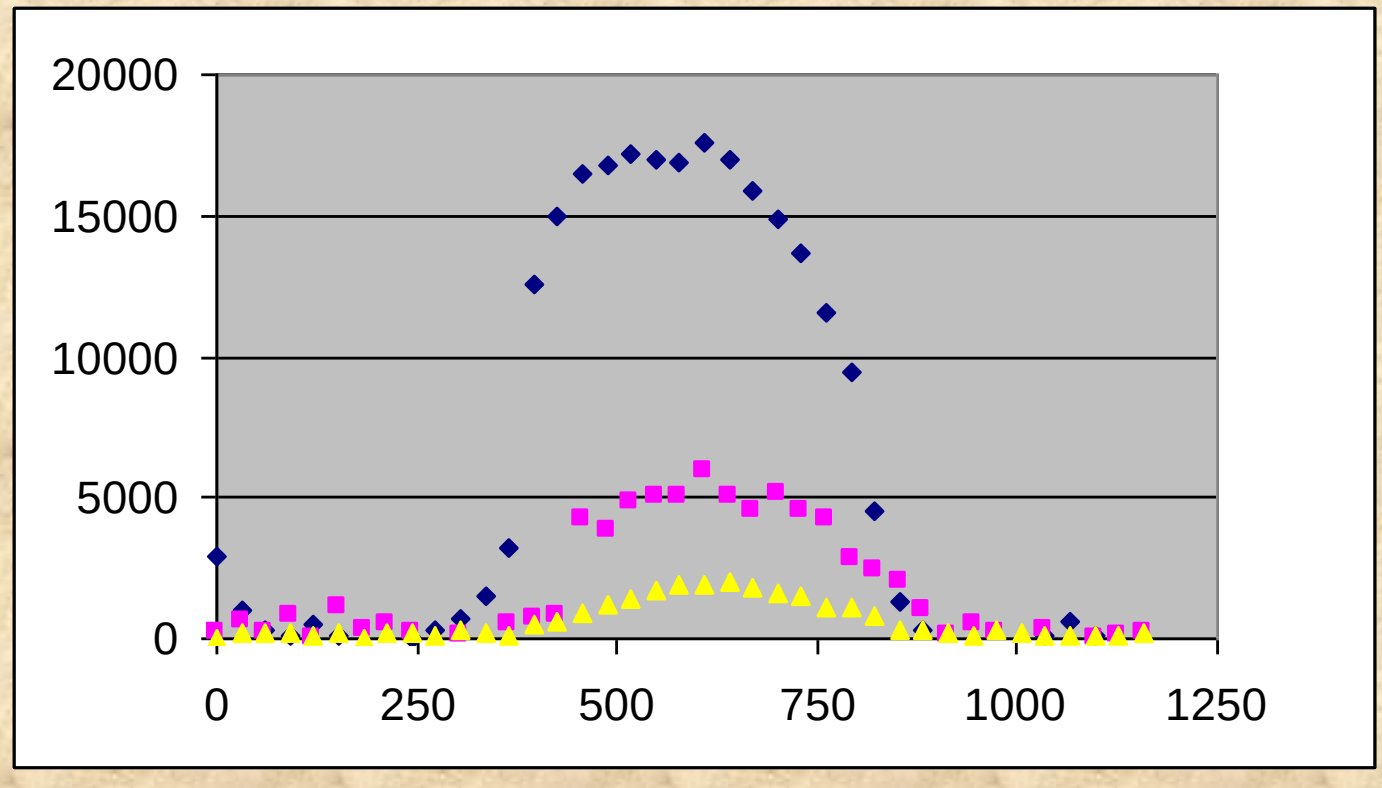
Organic cloud droplet residues

(TEM bright field)



Anderson, Crozier – ASU
Twohy - OSU



Relative concentrations of carbon (blue), nitrogen (magenta) and sulphur (yellow) as functions of position (in nanometers) from 400 nm carbon rich particle.

Sampling strategy:

Short level legs below, above, and in cloud:

5-10 minutes out of cloud

shorter in cloud (because of concentrating effect of CVI)