

CHARACTERIZATION OF CHEMICAL AND PHYSICAL PROPERTIES OF PROPOSED SIMULANT MATERIALS.

G.P. Meeker

U.S. Geological Survey, Denver Microbeam
Laboratory, MS 973, Denver Federal Center, Denver,
CO 80225, gmeeker@usgs.gov.

In order to develop simulated soils with the desirable properties it will be necessary to characterize:

prospective source materials
and
final products

on the micro and macro scales for

chemistry, mineralogy, water content, grain size, grain morphology, and other properties

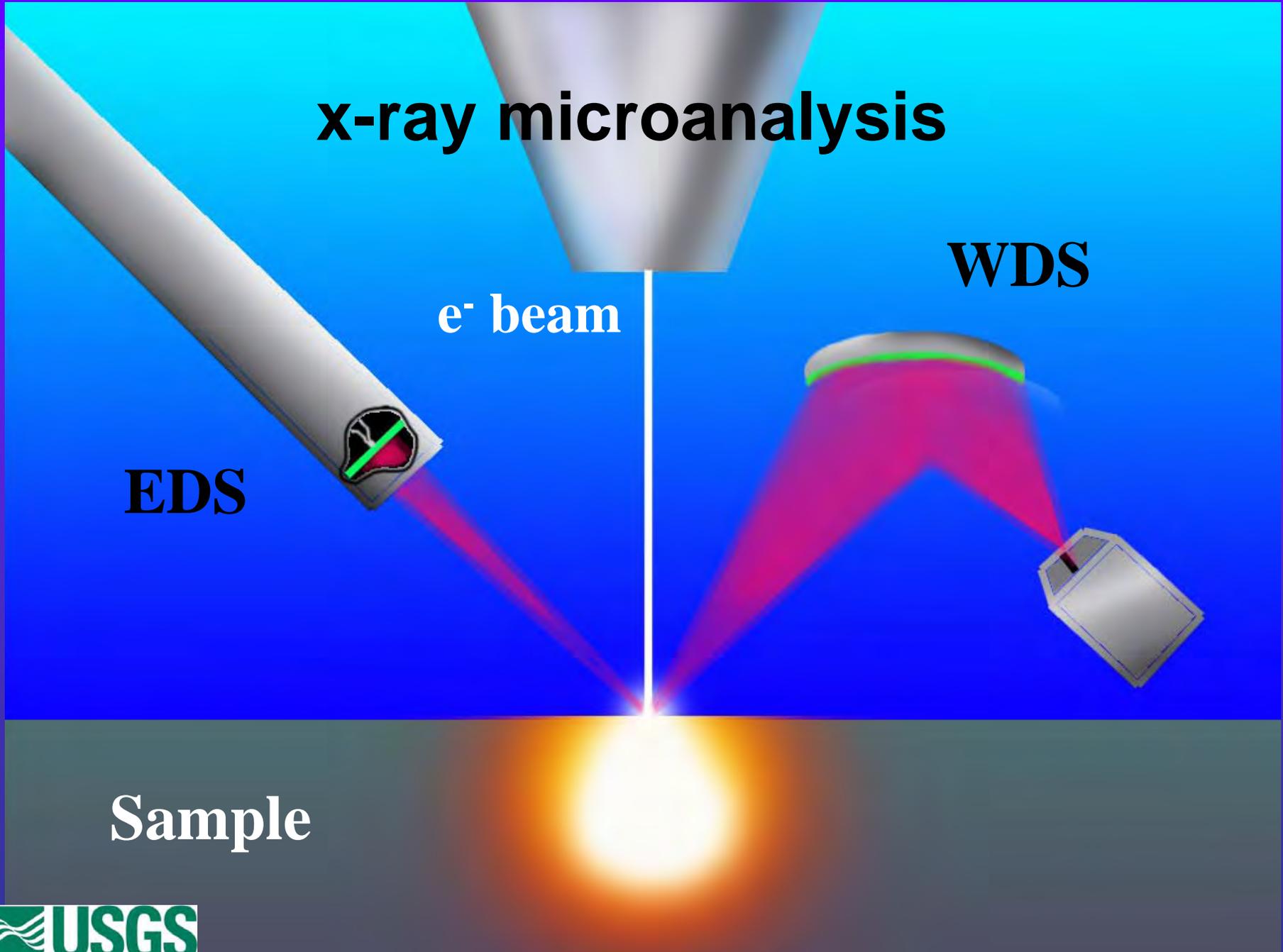
Analytical methods for characterization of simulant

- x-ray fluorescence, x-ray diffraction, x-ray microanalysis (EDS, WDS), ICP-MS, and ICP-AES for mineralogy and for major, minor and trace elements.
- Scanning electron microscopy, and particle size analysis will be required for morphology.
- As needed: neutron activation analysis, secondary ion mass spectrometry, transmission electron microscopy, thermal ionization mass spectrometry, leachate analysis, mossbauer spectroscopy, mid- and near-infrared spectroscopy differential thermal analysis, surface analysis, and other analytical techniques

Analytical methods for characterization of simulant

- Bulk chemical
 - x-ray fluorescence, x-ray diffraction, ICP-MS, and ICP-AES, DTA, INAA, leachate, ??
- Bulk Physical
 - Particle size, conductivity, cohesion, ??
- Microanalytical
 - EPMA, SEM/EDS, TEM
 - Size, shape

x-ray microanalysis



Quantitative analysis

Electron probe microanalysis (EPMA)

Accuracy - +/- 2% relative for majors and minors on polished samples

Sensitivity ~ 100-200 ppm

Requires well-characterized standards

Requires knowledge of minerals

Qualitative analysis

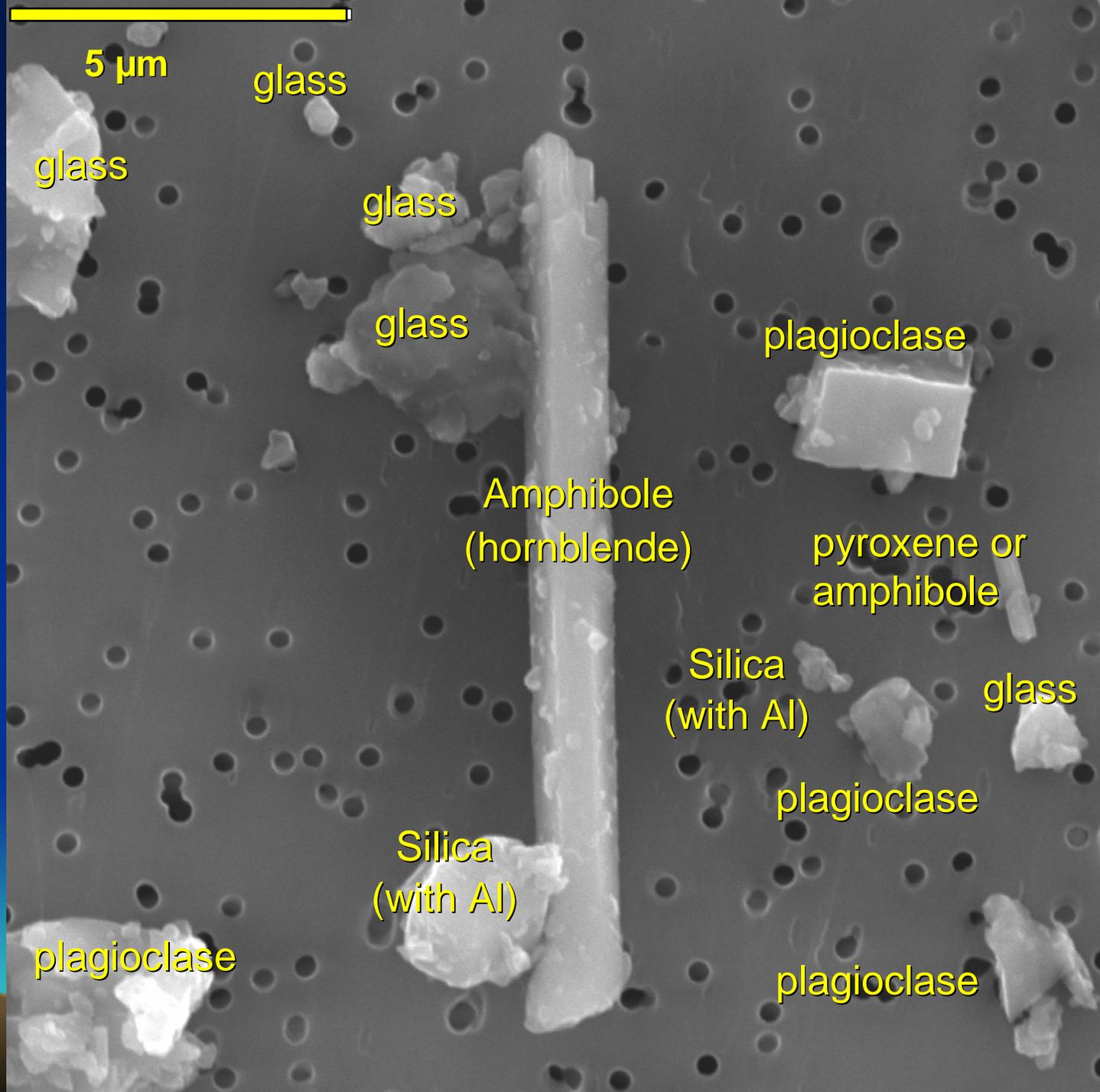
Energy dispersive spectroscopy, usually SEM/EDS

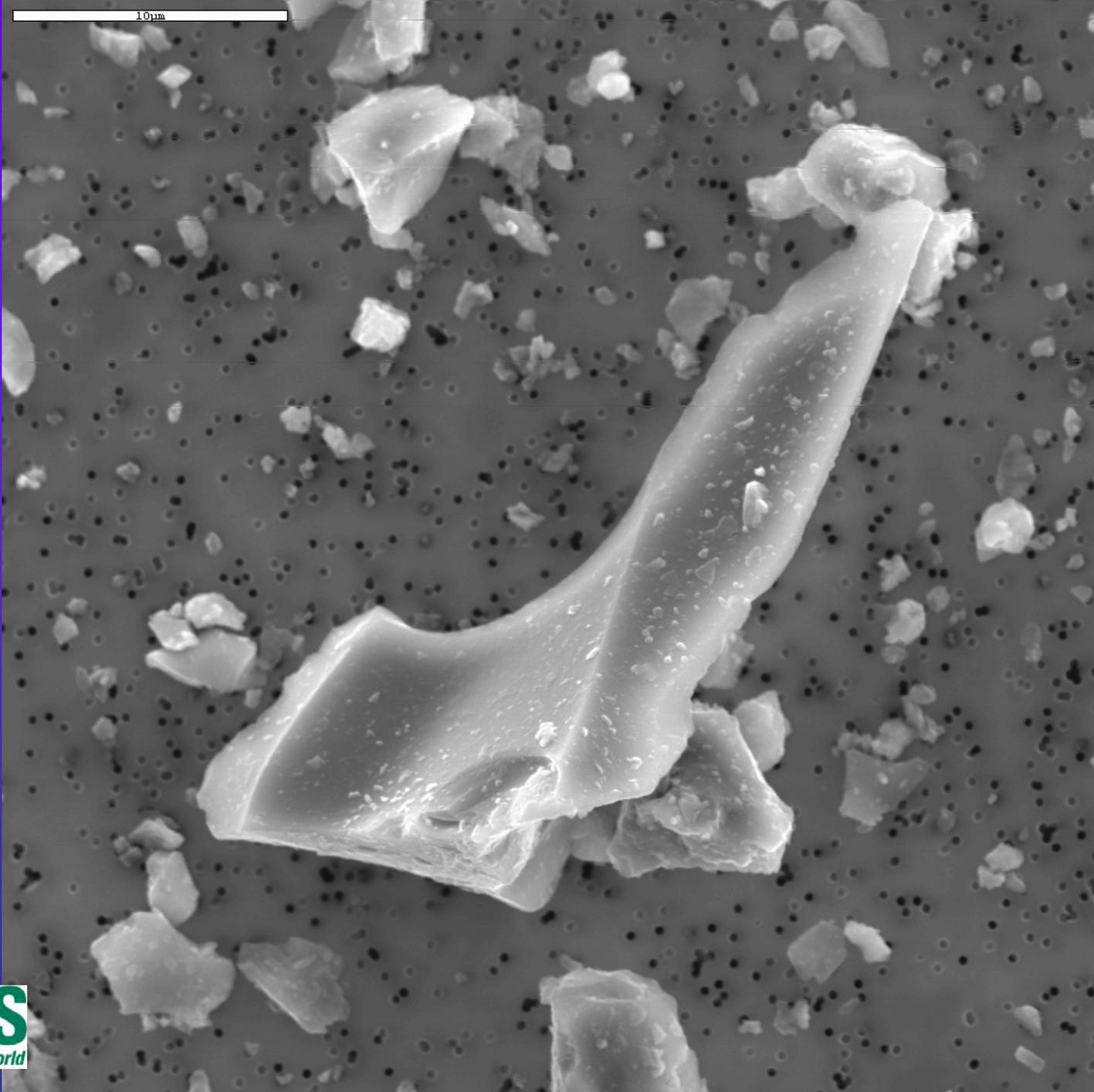
Accuracy +/- 10-20% relative

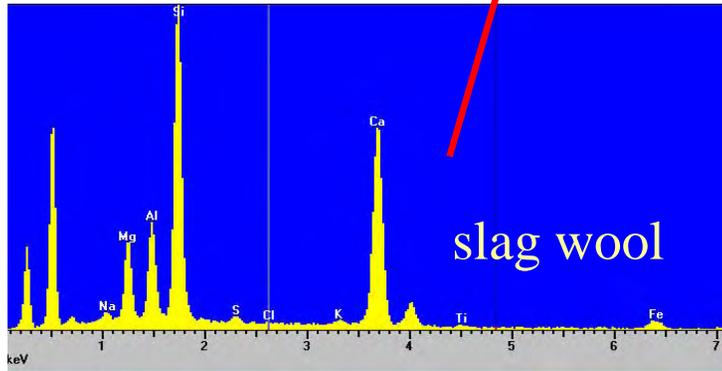
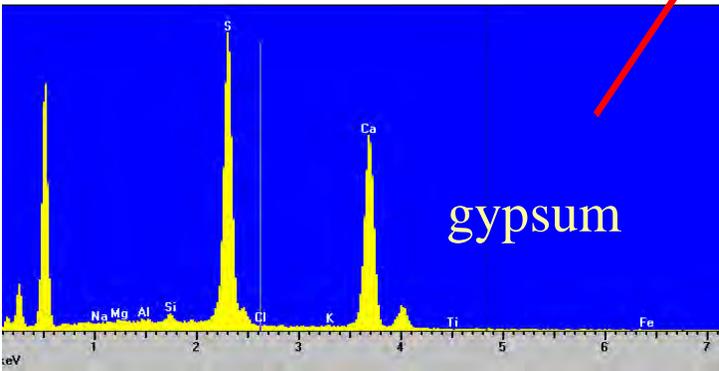
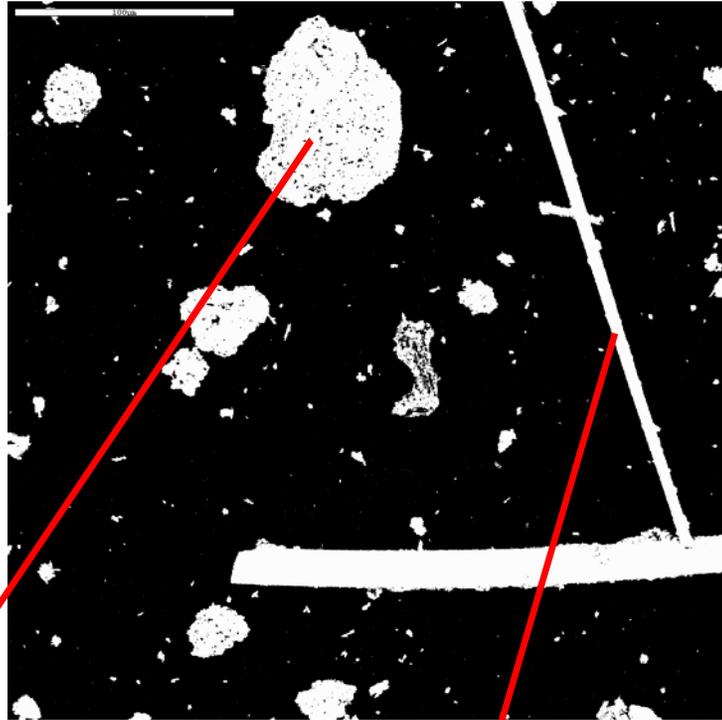
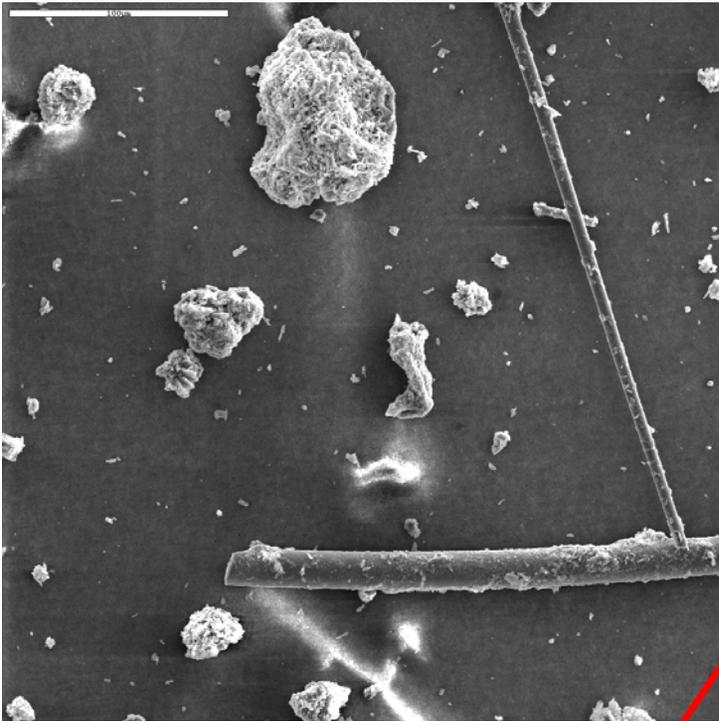
Sensitivity ~ 1000 ppm

Requires knowledge of particle-beam interaction

MSH
sample
10-04-04
SEM
image
(sample
suspended in
alcohol, then
filtered)







Methods of particle analysis

Manual

- morphology – less accurate

- chemical typing - slow but accurate

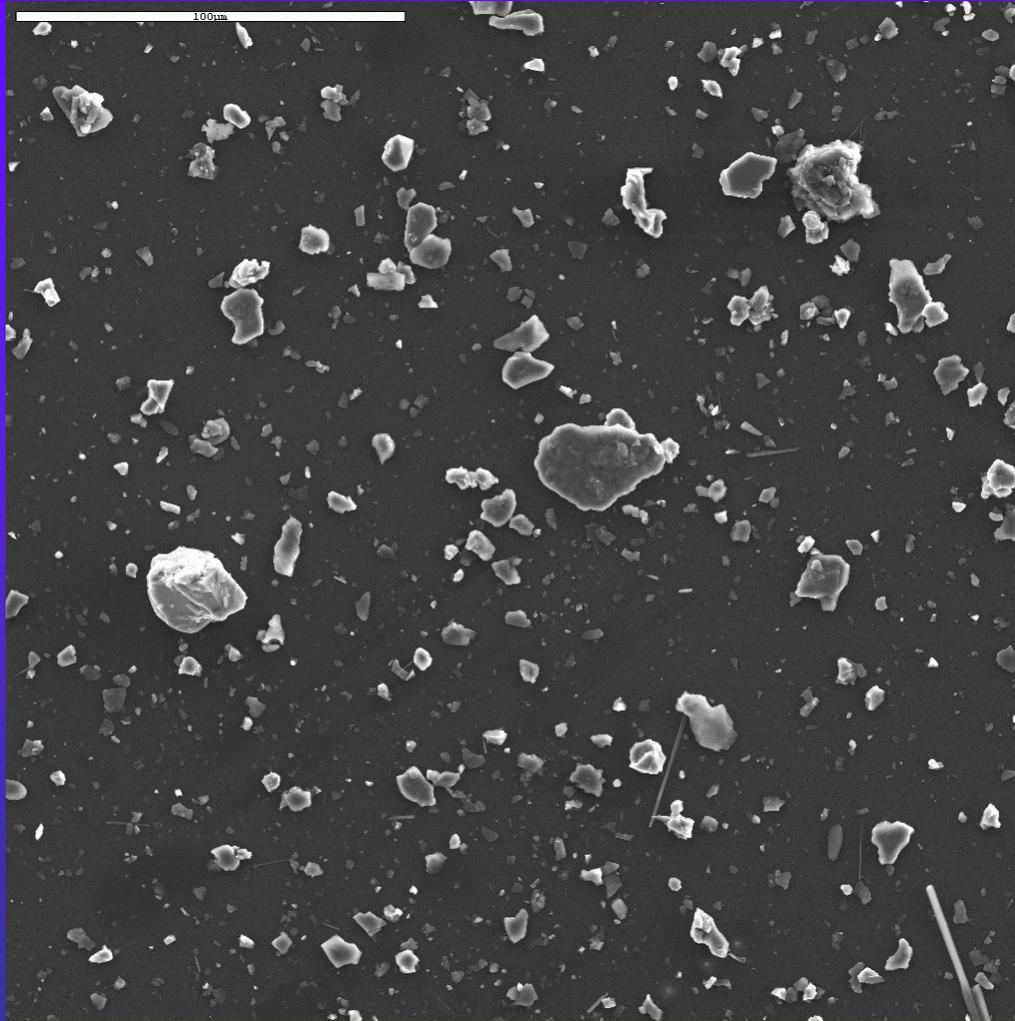
Automated

- morphology based – fast but chemistry less accurate

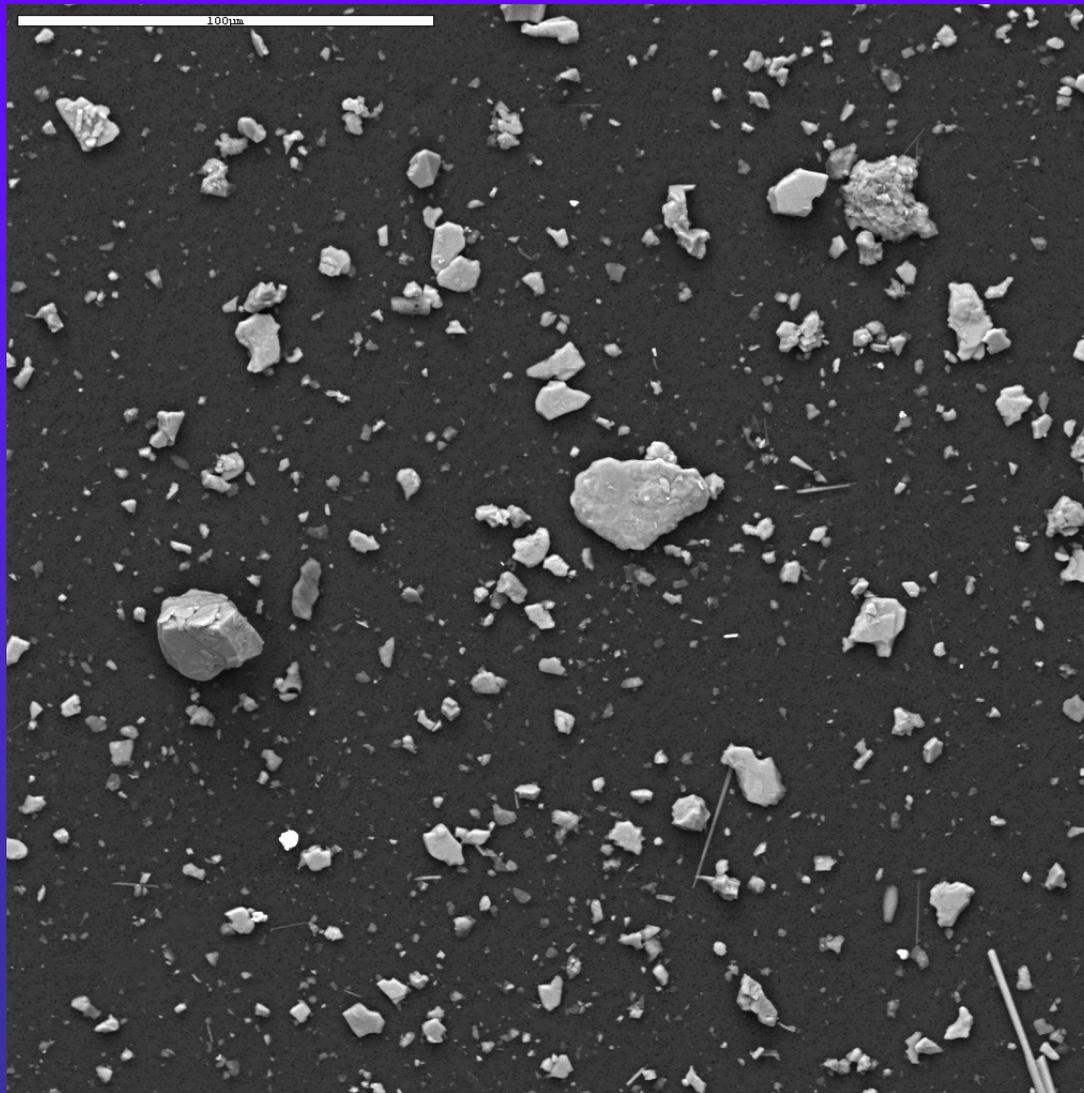
- chemistry based (spectrum imaging)

Combined

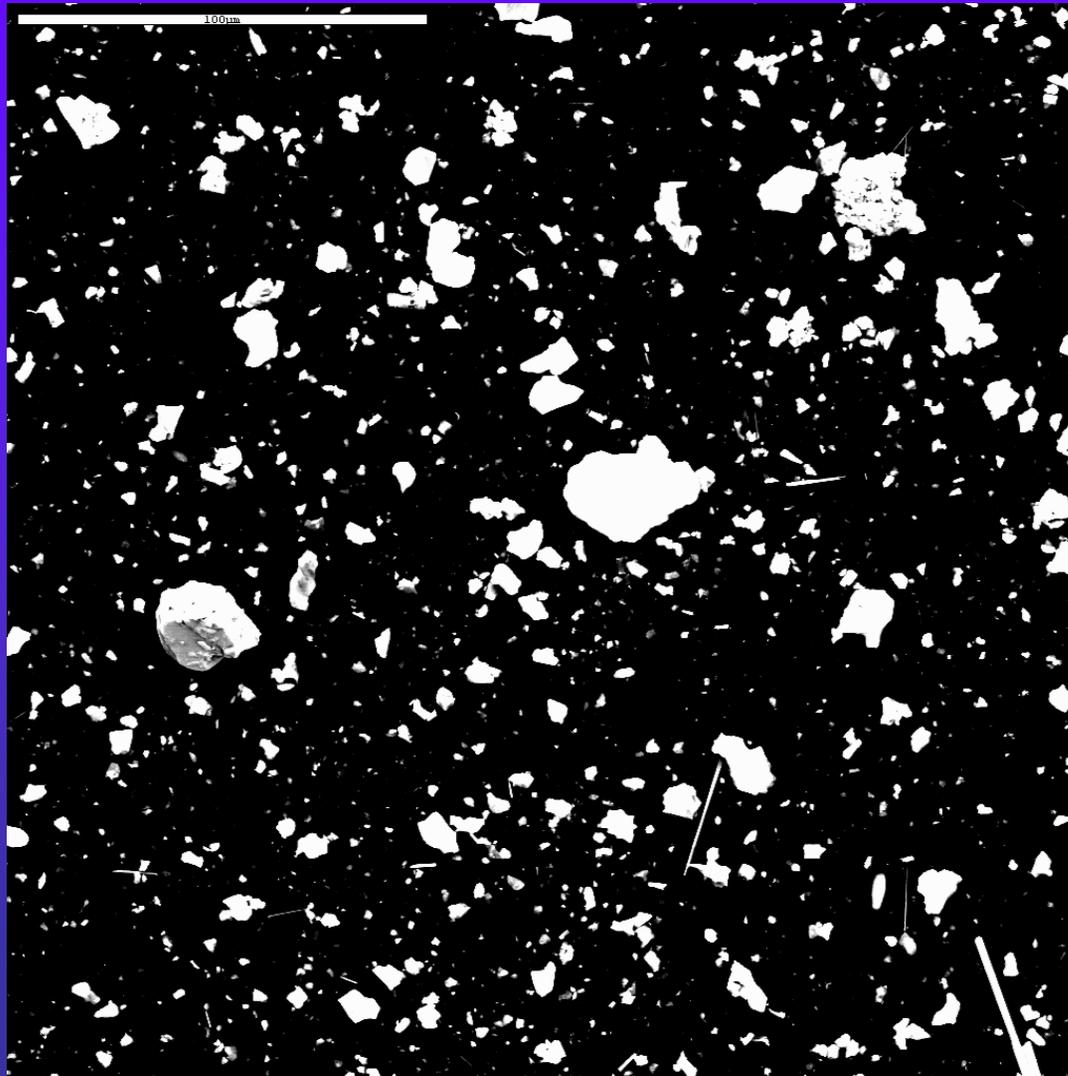
Secondary electron image



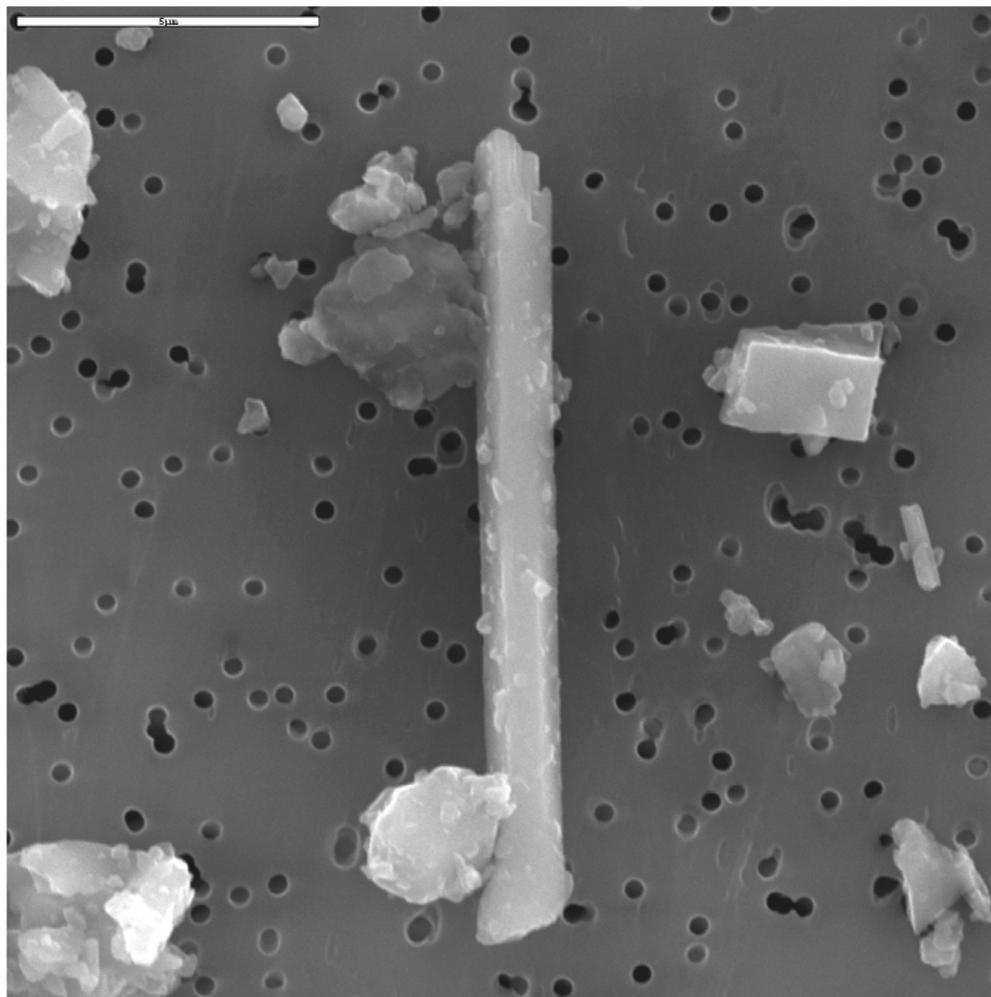
Backscattered electron image



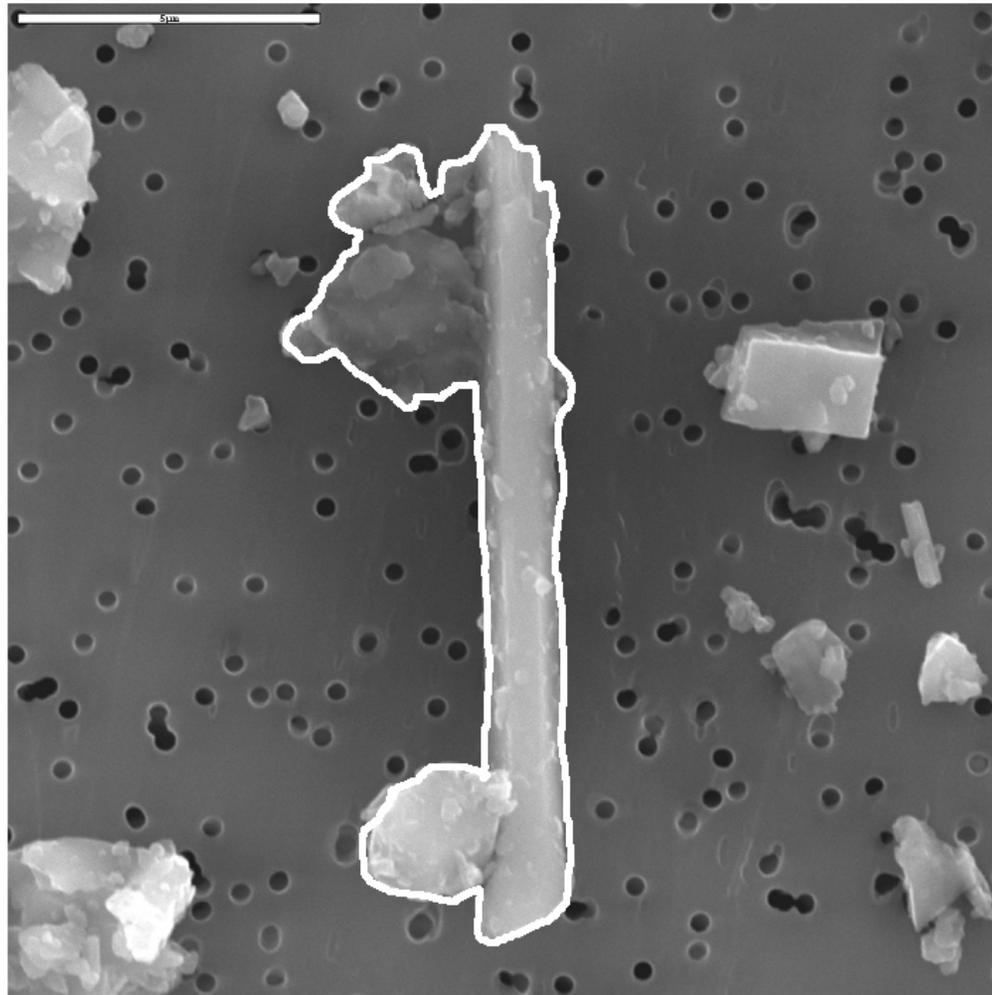
Binary image

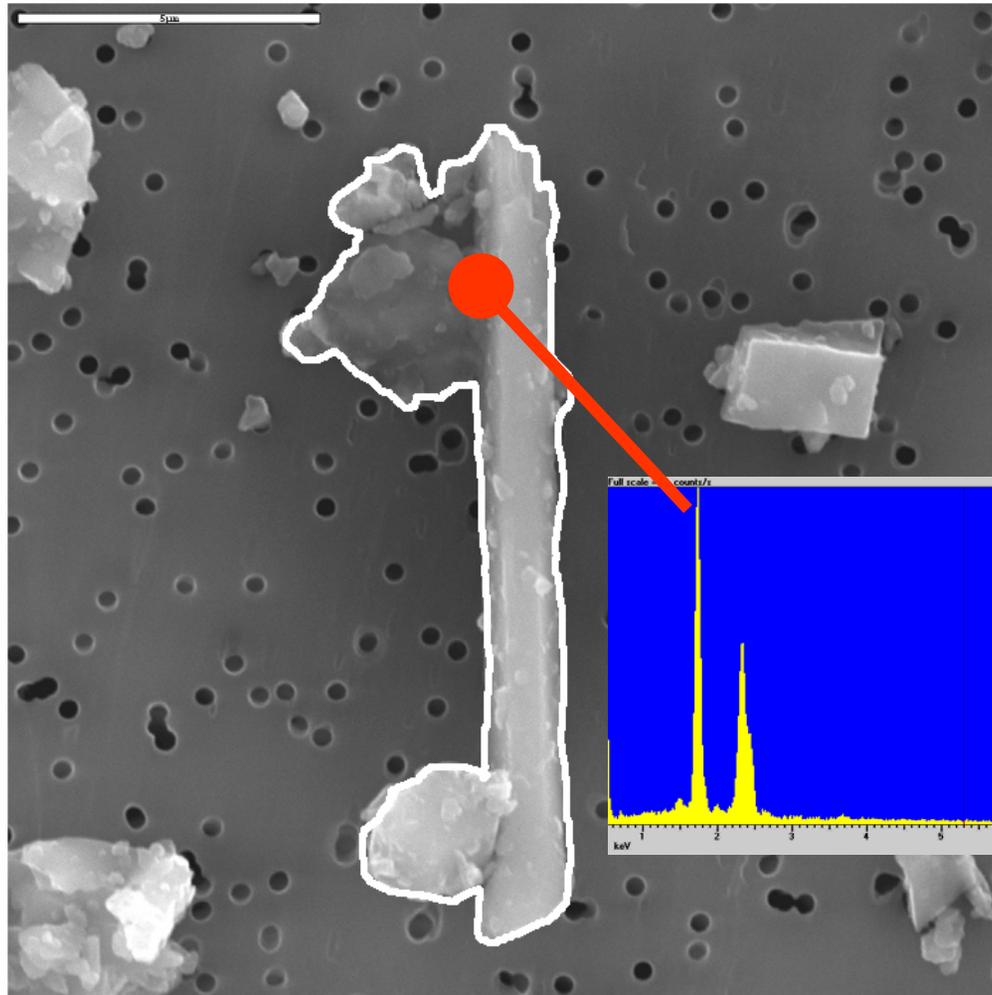


Automated feature analysis

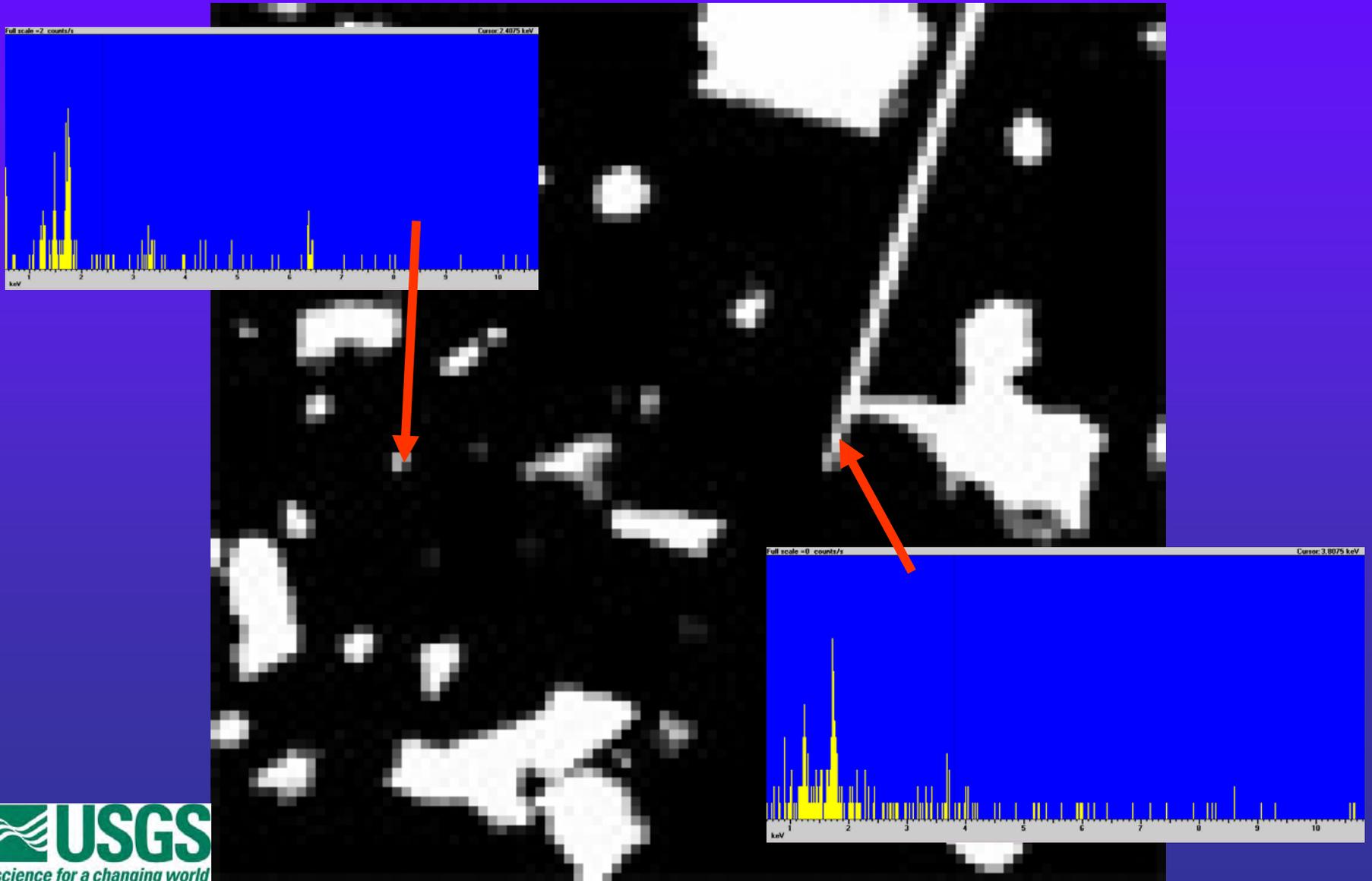


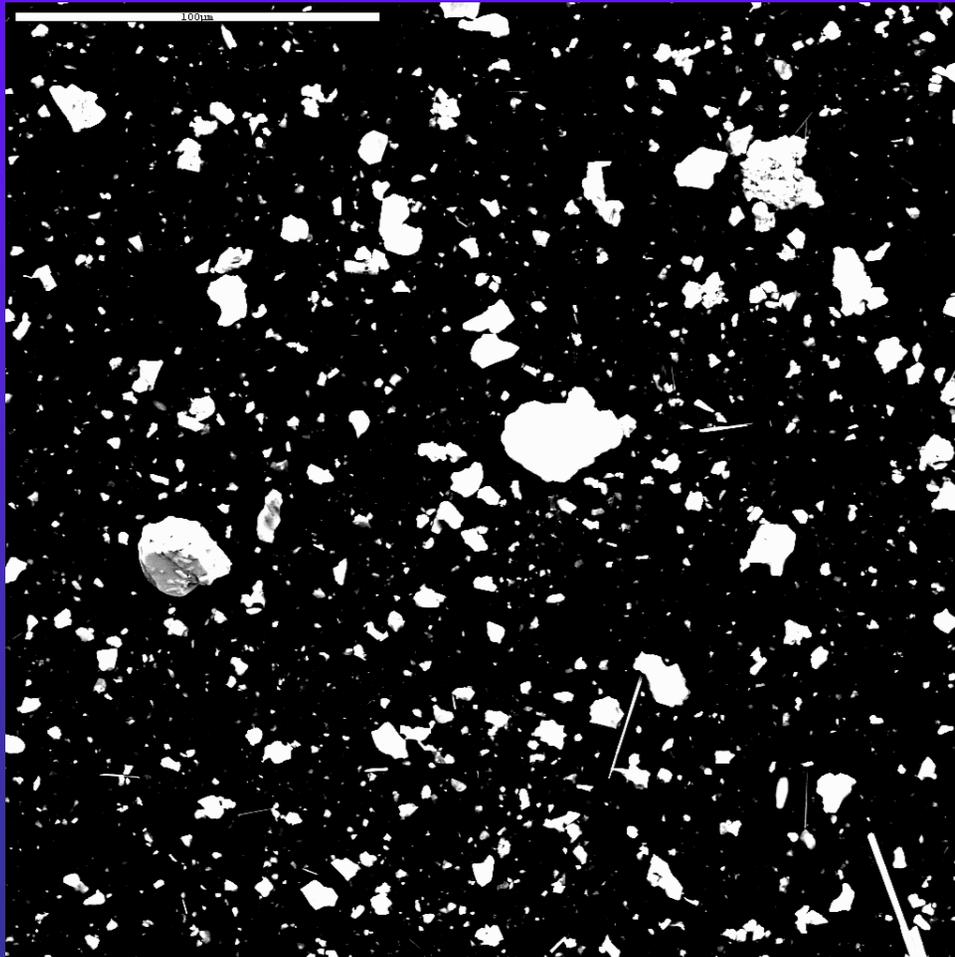
Automated feature analysis

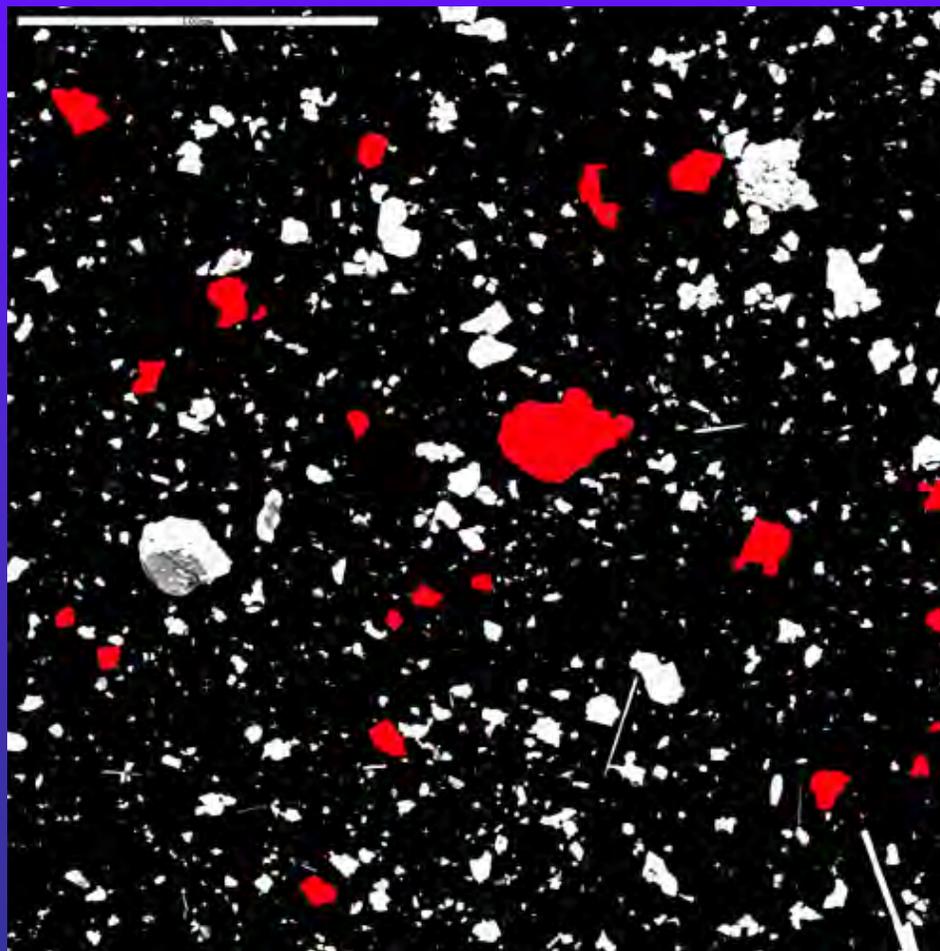




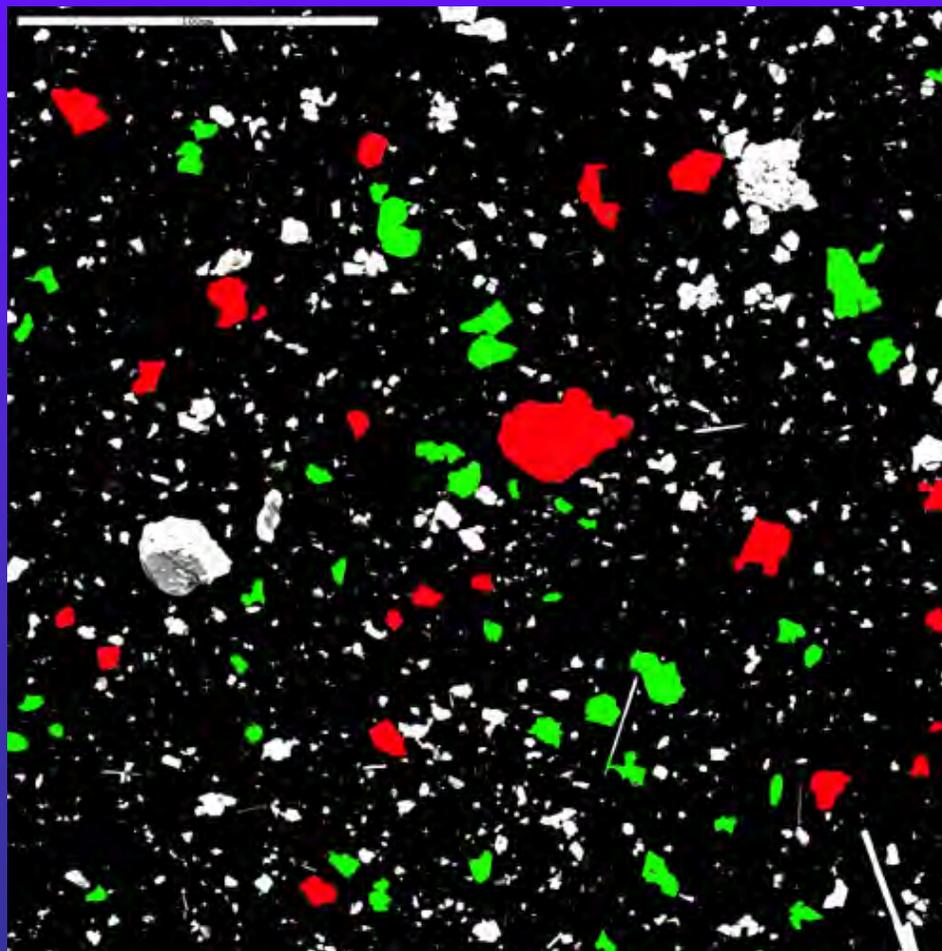
Spectrum Imaging





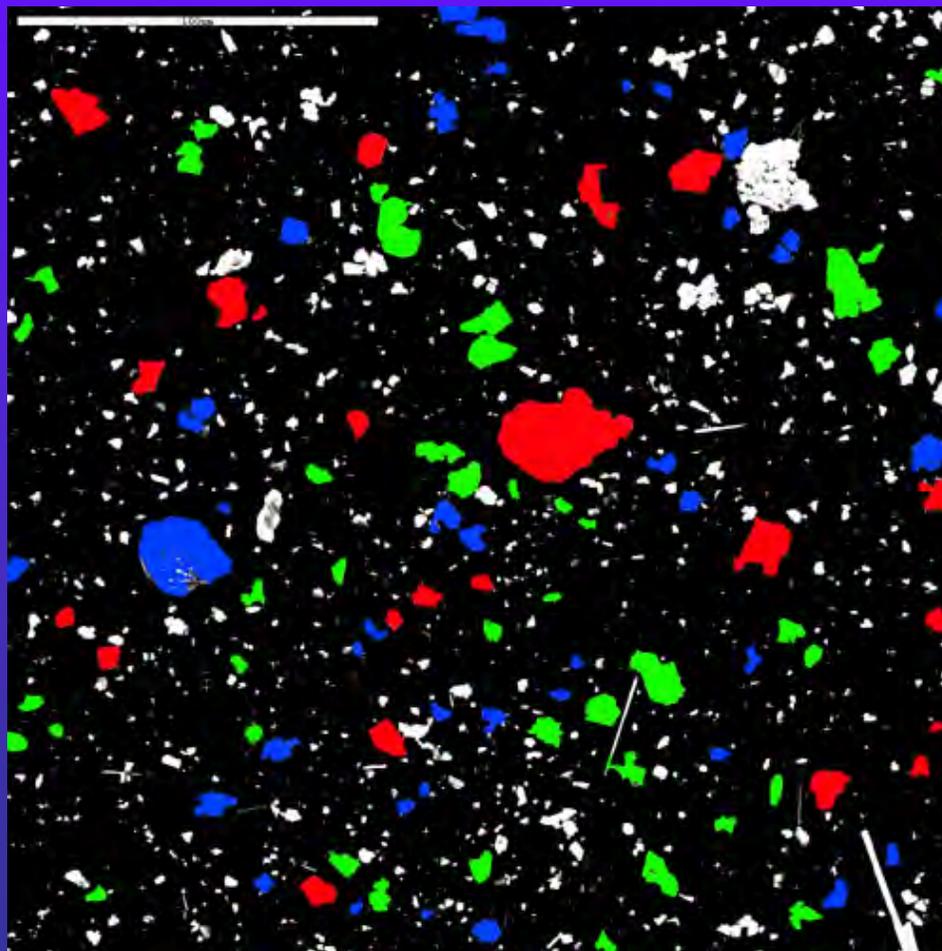


Phase 1

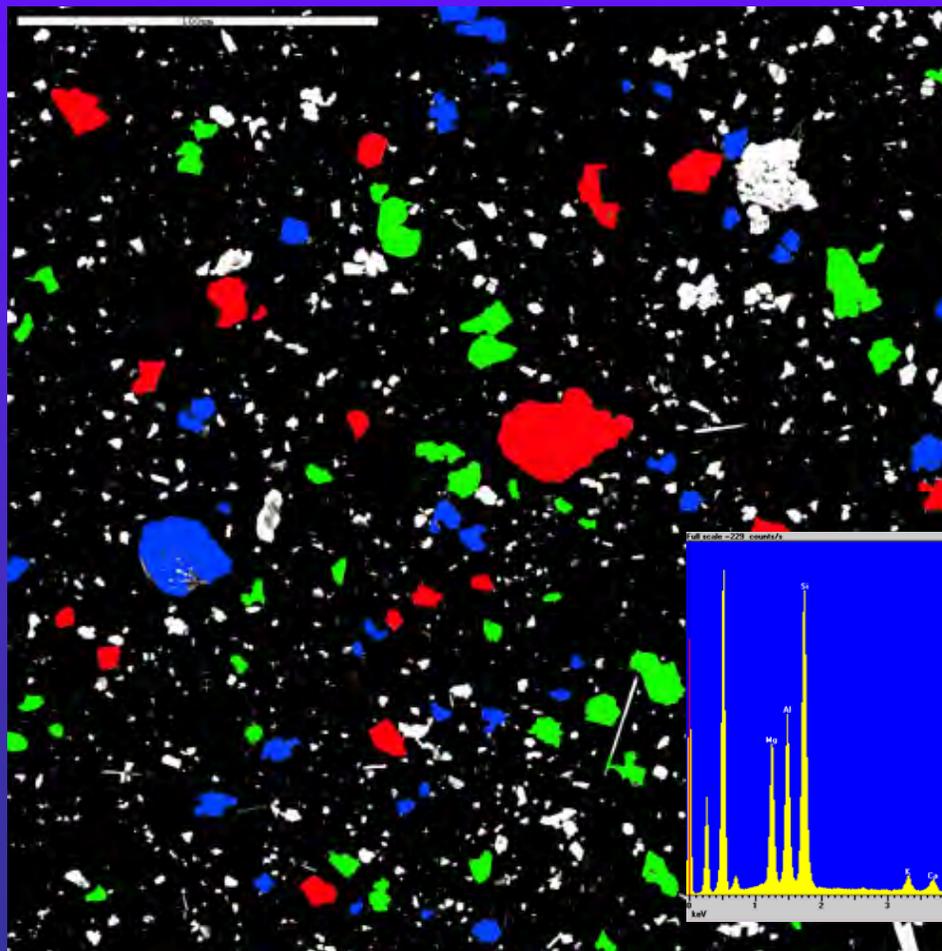


Phase 1

Phase 2



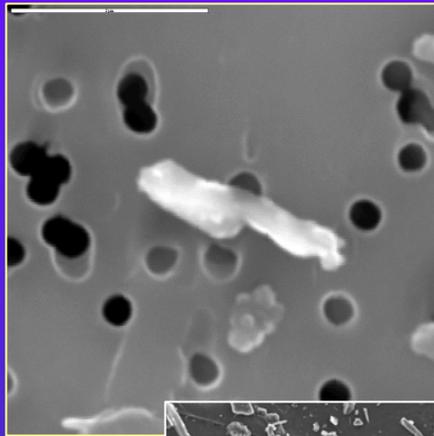
Phase 1
Phase 2
Phase 3



Phase 1
Phase 2
Phase 3

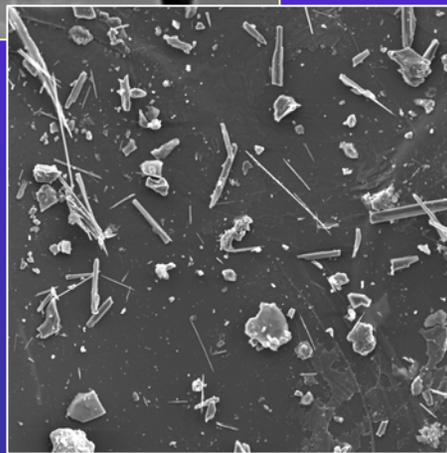
Safety Concerns primarily respirable ($< 3\mu\text{m}$)

- Silica

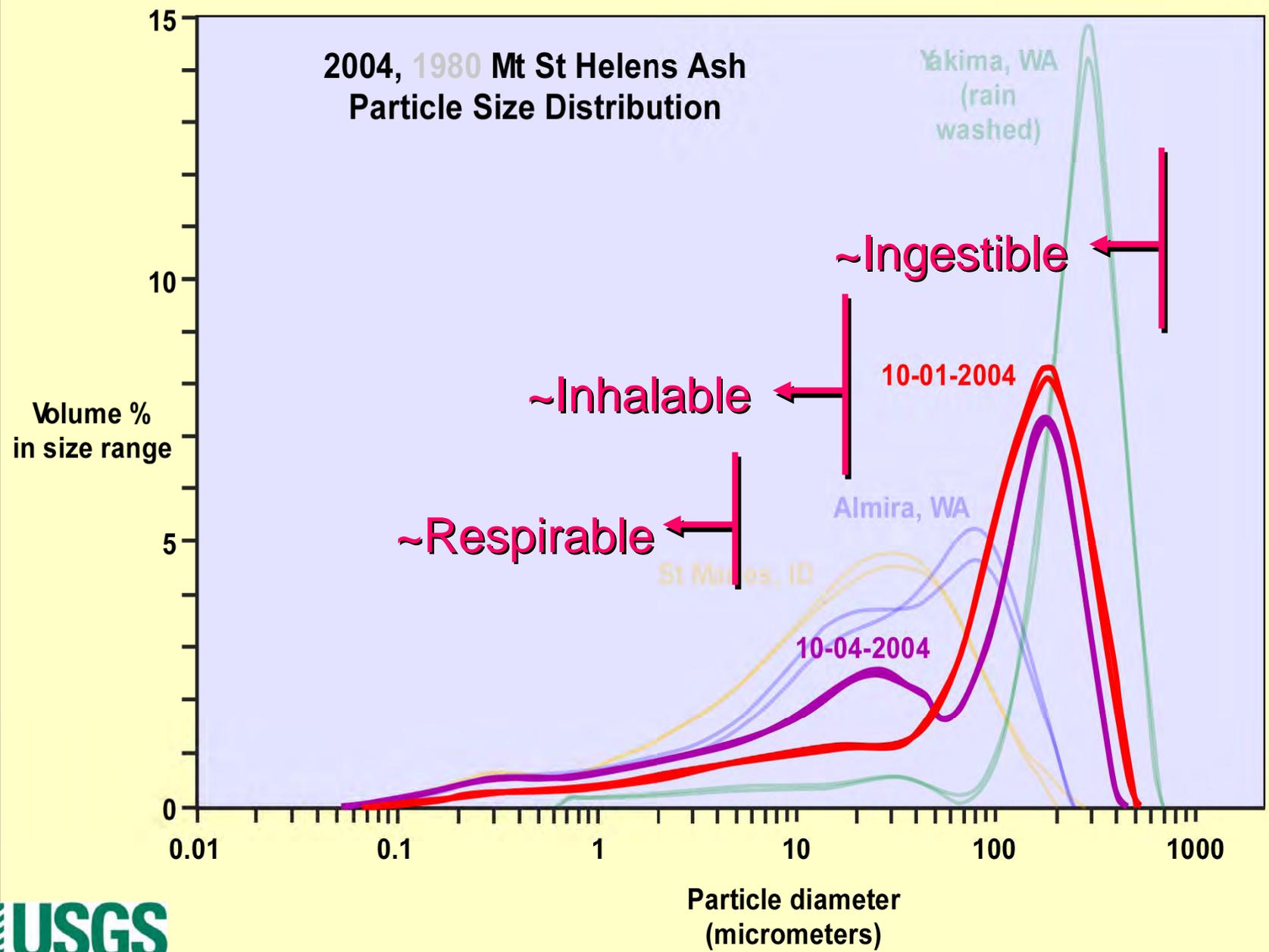


- Bio-available Mn, Cr, Ni, Al, Fe, ?

- Asbestos



2004, 1980 Mt St Helens Ash Particle Size Distribution



USGS –

- Simulant production capabilities
- In-house analytical capabilities
- Extensive experience with rock and mineral material
- Extensive experience with production of large volumes of homogeneous reference materials
- Experience with analysis for hazardous materials