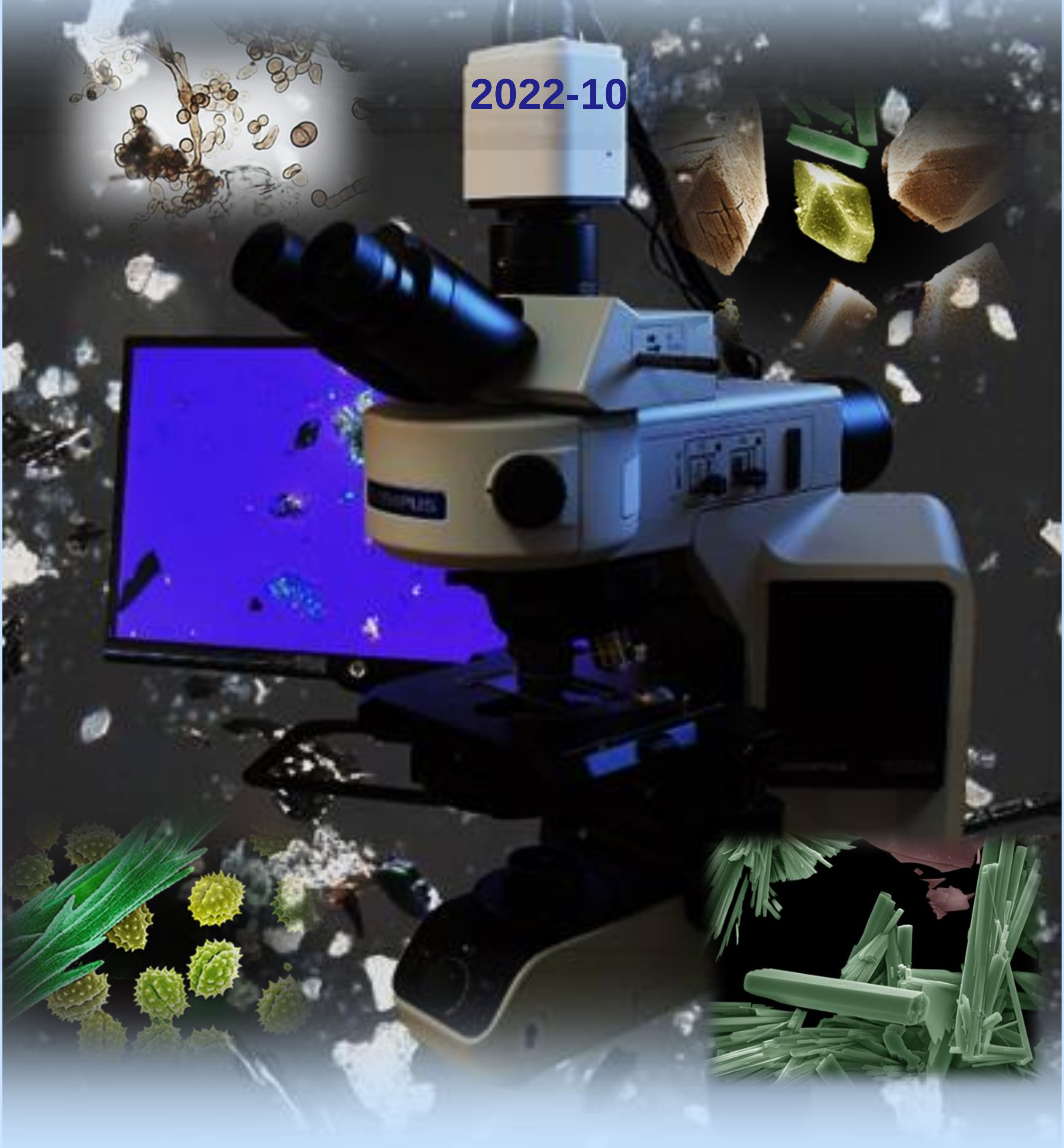
ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

AIRBORNE AND SURFACE DUST ANALYSIS INTERPRETATION GUIDE

2022-10



This document provides the clients of Environmental Analysis Associates, Inc. with suggested guidelines for interpreting our laboratory analysis reports. The suggested percentile classifications and numerical guidelines may not apply to samples analyzed by other laboratories, nor should they be used by themselves as an indicator of "contamination" or a safe or unsafe environment. For more information regarding testing services please contact Mr. Daniel M. Baxter at dbaxter@eaalab.com.

APPROPRIATE USE OF THE AIR PROFILE GUIDELINES

AIR PROFILE ™

IMPORTANT : Providing hazard communication, or make recommendations for remedial action should always first be based on a thorough visual inspection and the professional judgement of a trained environmental professional. The suggested terminology and exposure evaluation criteria given below specifically addresses the statistical comparison of individual samples with the airborne percentile concentration ranges measured within our database of occupied buildings. It does not take into account the critical observational data that is required to render an accurate and complete exposure assessment for any specific building. In other words, the percentile ranges and descriptive terminology cannot directly be used as the sole criteria to infer a “safe”, "unsafe", or “elevated" condition is present.

The ***AIR PROFILE***™ and ***DUST PROFILE***™ Guidelines are intended to be used as a diagnostic tool to 1). Help the investigator identify and obtain a profile of potential mold and/or dust conditions that are not readily observable, 2). Use the resulting quantified assemblages to determine the potential origin of “atypical” contamination levels, and 3). Compare and classify the measured levels found inside a specific building with a database collected from other buildings using industry accepted methods.

Since "hazard" levels or permissible exposure limits (PEL's) are not available for mold and other types of common dust particles, the terminology commonly used for exposure assessment, e.g. "acceptable" "uncertain", and "unacceptable", are not directly applicable.

Environmental Analysis uses the terminology of "Typical", "Atypical", and “Elevated“ to define statistical concentration ranges based on a comparison with our nationwide database. The classifications are divided into six (6) ranges (representing the <50th, >50th, >75th, >90th, >95th, and >99th percentiles respectively) to interpret both airborne and surface concentration data.

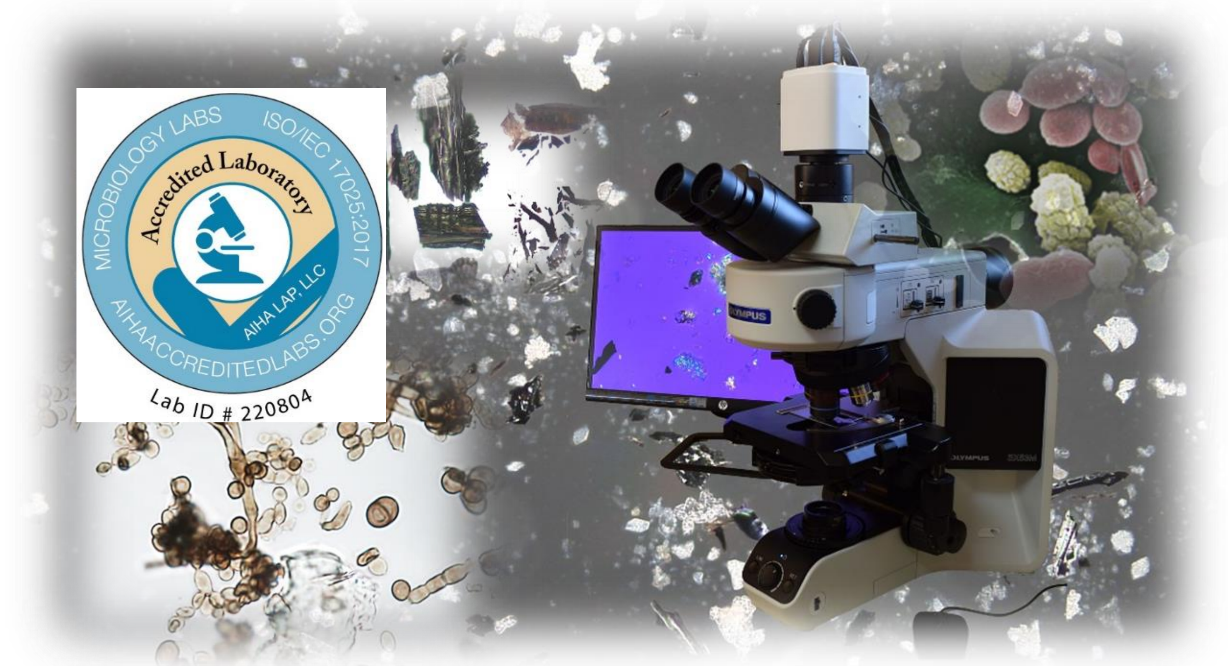
The categories have two (2) levels for each descriptive percentile classification, and are defined and color-coded as follows:

Typical - 1	Measured frequency of less than the 50th percentile - typically found in clean or low impact buildings.
Typical - 2	Measured frequency between the 50th and 75th percentile - typically found in “average” or typical buildings.
Atypical - 3	Measured frequency between the 75th and 90th percentile - found marginally above typical buildings.
Atypical - 4	Measured frequency of between the 90th and 95th - percentile found in buildings with atypical dust levels.
Elevated - 5	Measured frequency between the 95th and 99th - found in buildings with elevated exposure levels.
Elevated – 6	Measured frequency exceeding the 99th percentile - found in buildings with significantly elevated exposure levels.

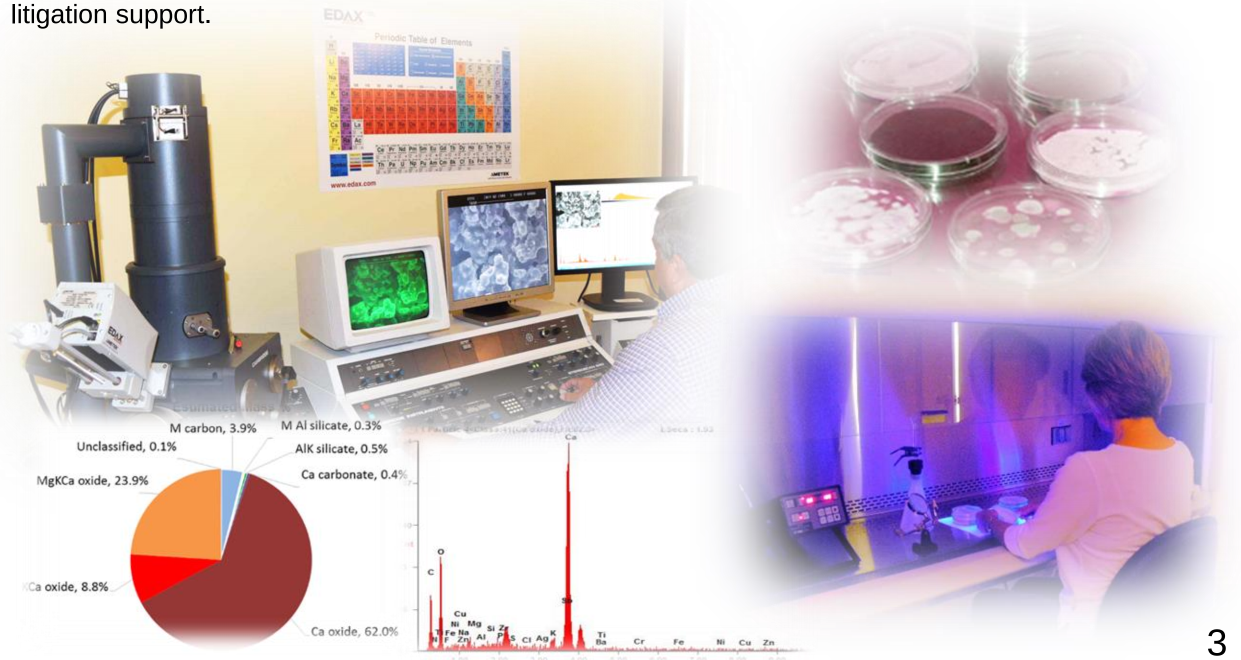
CONSULTING & TESTING SERVICES

Environmental Analysis Associates, Inc. is dedicated to providing state-of-the-art indoor air quality particle testing services using an integrated system of Optical Microscopy and automated Scanning Electron Microscopy analysis methods. When combined with our 40 years of field and consulting experience, we can fully support our clients in finding the source and solution to dust-related indoor air quality complaints.

The Michigan Laboratory (Lab ID#: 220804) is AIHA-LAP accredited for mold spore analysis. The Michigan Lab also specializes in the analysis of all types of surface and airborne dust, bacteria and fire / combustion residue.



The SEM laboratory specializes in trace particle analysis, product defect and failure analysis testing, and litigation support.



AIR PROFILE™

Airborne and Surface Dust Analysis Using Optical Microscopy and Scanning Electron Microscopy

Version 9 of method guide is based on our nationwide database of over 3,500 indoor and 1,000 outdoor airborne Air-O-Cell dust samples collected between 2017 and 2018. A statistical summary of this data is available as a separate document upon request. This guide provides statistical percentile comparison levels for surface dust concentrations based on over 700 samples collected nationwide. The percentile levels for surface dust concentrations are incorporated into the ***DUST PROFILE***™ color-coded tables beginning on page 12.

Environmental Analysis Associates, Inc. (EAA) is one of only a few environmental testing laboratories in the country specializing in comprehensive dust and airborne aerosol testing using the full range of Optical and Scanning Electron Microscopy methods. Our historical investigation and consulting expertise also helps us provide you with knowledgeable support and data interpretation specific to your indoor air quality problems. Mr. Daniel Baxter is the owner of EAA, and inventor of the Air-O-Cell®, the most widely used airborne mold and dust sampler in the country.

The guide provides practical and industry accepted statistical comparison guidelines for the interpretation of indoor dust samples using Optical Microscopy methods. The EAA ***AIR PROFILE***™ Optical Microscopy color-coded guidelines and report data summary tables are based on this nationwide database. The guidelines allow direct comparisons of indoor airborne mold and other dust particle results from one building with a historical database from other buildings. These guidelines are based on airborne sampling data collected with the Air-O-Cell® slit impaction sampler, and surface adhesive tape lift sampling using the Zefon Bio-tape® media or cellophane tape. EAA has systematically classified and quantified the most commonly occurring particle categories found both indoors and outdoors.

The EAA ***AIR PROFILE™*** guidelines may not apply to samples analyzed by other laboratories or collected using other sampling devices. Since industry accepted exposure levels for mold or other particles classified in the EAA reports do not currently exist, the data should be used as a "screening" tool to determine the difference between typical and atypical indoor dust conditions. The data cannot be used as a basis for declaring an safe, unsafe, or contaminated; or as a substitute method to satisfy EPA, OSHA, or other governmental standards. The 1999 ACGIH document entitled *Bioaerosols Assessment and Control* uses the percentile frequency of occurrence as a comparison metric in "non-problem" buildings, and suggests that new data must exceed the 90th or 95th percentile to be considered indicative of a potential for harm. The EAA classification guidelines uses this same statistical method to classify and rank exposure. Specifically, the frequency of occurrence at the 50th, 75th, 90th, 95th, and 99th percentiles are used as the primary comparison criterion. The EAA guidelines and EAA analysis reports should be used as a secondary information to supplement an onsite visual inspection and industry accepted tests where they are applicable.

Although it is often not possible for the microscopist to precisely identify all particles or a specific emission source, identifying "atypical" particle ranges within a specific particle classification is the first step used to identify and locate a potential contamination source. Identification and classification procedures use the full range of optical microscopy methods including transmitted light bright field (BF), polarized light microscopy (PLM), and reflected light/dark field microscopy (RLDF). Samples can be further analyzed for their elemental chemistry and size distribution (when warranted) by automated Scanning Electron Microscopy. These new automated SEM/X-ray analysis procedures developed by EAA allow the precise chemical and size analysis of particle assemblages, and the identification of indoor contamination source(s). A flow diagram for comprehensive analysis is given on page 7 of this guide.

THE DIFFERENCE BETWEEN INDOOR AND OUTDOOR AIR

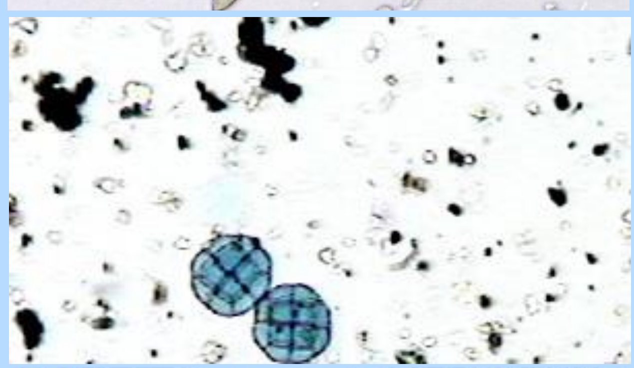
There are significant differences between the indoor and outdoor dust particle "*assemblages"*. A dust particle "assemblage" is a grouping of different types of particles that are found in association with each other within defined types of environments, or when found together, may point to a specific source or environmental condition. Assemblage analysis is commonly used in archeology, and the dating of fossils or pollen. Until recently, it has not routinely been used as a systematic method to identify or quantify potential indoor air quality problems. For the most part, existing indoor air quality regulations address ventilation, and individual exposures to regulated toxic, irritant, or volatile chemicals or particles without evaluating their inter-relationship. These standard methods work well when there is a defined odor and/or known exposure hazard that has been identified. This approach is less successful when used to solve nebulous complaints associated with perceived irritation. In other words, if the particle type is not classified as hazardous or an irritant, even if the concentrations are exceedingly high, they are not routinely assessed or monitored by traditional EPA, OSHA, or ASTM methods. A systematic evaluation of the concentration and distribution of particles that are representative of the operational conditions of a building are usually helpful when standard or regulated material testing methods fail to resolve a complaint. EAA fills this testing gap by analyzing and profiling the difference in particle distributions generated by these varied operational conditions. The deviations in outside filtered air are often responsible for irritation or comfort complaints, or indicative of adverse building "shedding" conditions that can be identified and resolved. Several illustrative examples of different particle "assemblages" and their relationship to a building environment are given on the following two pages.

Outdoor air – rural / natural background profile

- *Vegetation particles*
- *Pollen*
- *Mold spores*
- *Soil minerals*
- *Insect droppings*

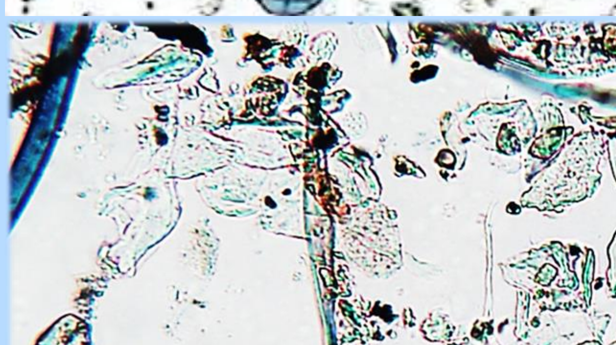
Outdoor air – city / urban / industrial profile

- *Outdoor air particles described above*
- *Road dust – asphalt & tire rubber*
- *Automotive combustion particles*
- *Soil particles*



Indoor office & residential environment profile

- *Primarily skin cells*
- *Clothing, furniture, & carpeting fibers*
- *Decayed biogenic debris*
- *Building generated HVAC & building materials*



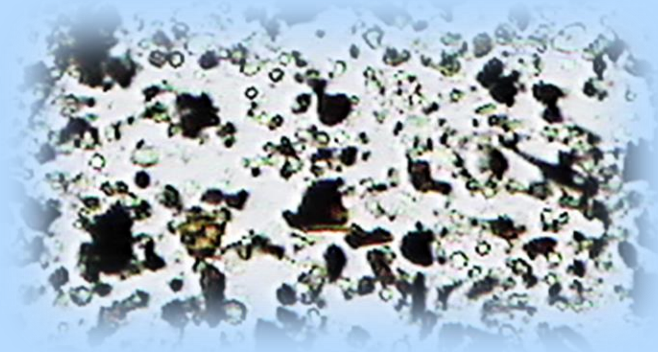
THE INDOOR DUST ENVIRONMENT

Given below are some examples and photo-micrographs of the most common and atypical “assemblage” conditions caused by “building generated” particles.

INDOOR PARTICLE “ASSEMBLAGES”

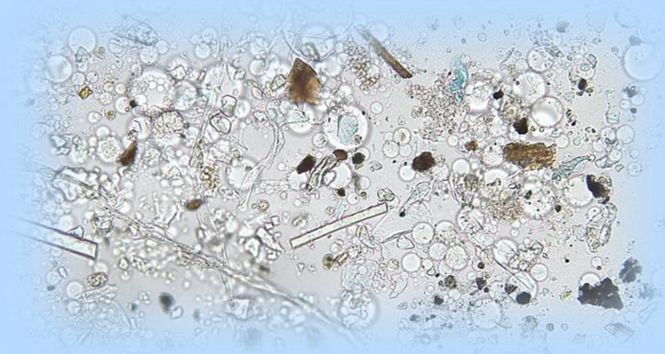
Biogenic particle shedding profile

- *Decayed bio-film particles*
- *Decayed vegetation*
- *Decayed skin cells*
- *Mold growth*



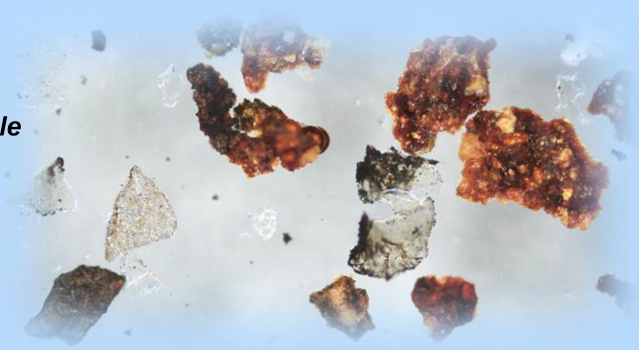
Construction renovation dust profile

- *Gypsum drywall dust*
- *Carbonate patching compounds*
- *Paint*
- *Fiberglass insulation*



HVAC / metal component corrosion dust profile

- *Al, Fe, Zn, Cu oxide metal flakes*
- *Salts- cations / anions, chlorides, etc.*
- *Rubber belt / gasket / insulation particles*



Fire / combustion residue profiles

Wildfire

- *Soot / char / ash*
- *Burned soil particles*
- *Burned pollen grains*
- *Firestorm vegetation and soil particles*

Structure fires

- *Melted plastics, metals, fabrics, hydrophobic soot*

AIR PROFILE ™ THE EAA PARTICLE CLASSIFICATION SYSTEM

The EAA Particle Classification System uses particle morphology, optical properties, and assemblage association to classify common particles. In some cases the classification may not accurately represent the exact identity of an individual particle. Unusual particles can be placed in the “Other” category when found in elevated concentrations. Particle classifications can also be separated as being generated by biological (biogenic), or inorganic processes. Fibrous particles can be generated by biological, inorganic, or man-made processes. An analysis decision flow diagram is given on page 8.

BIOGENIC

Mold	Spores and filamentous structures generated from fungal growth
Algae and protozoan organisms	Chlorophyll producing “algae” spores or filaments and other protozoans associated with biofilm generation
Pollen & fern spores	Reproductive spores generated by flowering plants and ferns.
Skin cell fragments (Dander)	Skin cell fragments generated by human or animals
Insect parts	All particles associated with insects including leg parts, wing scales, and body chiton fragments

FIBROUS

Fibrous glass fibers (Isotropic)	Fibrous transparent glass fibers (fiberglass & mineral wool is used primarily as insulation materials and fillers in ceiling tiles)
Cellulosic fibers (Anisotropic)	Natural cellulosic fibrous materials used as clothing, paper, etc.
Synthetic fibers	Fibrous manufactured fibers used as clothing, bedding, drapes, carpeting, etc. (primarily nylon, rayon, etc.)

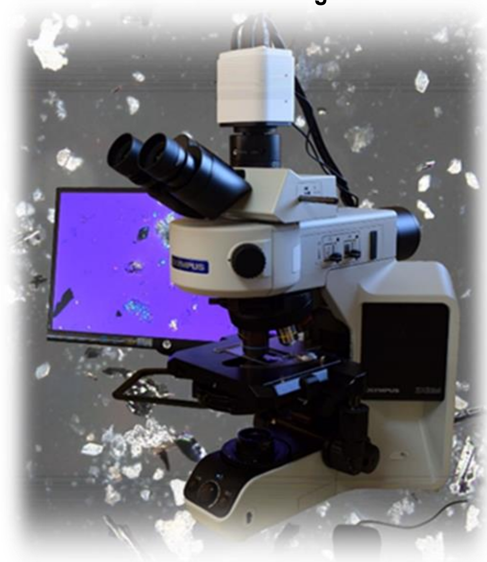
INORGANIC / ANTHROPOGENIC

Opaque particles	Particles that are optically opaque and appear as dark brown or black when using transmitted light microscopy. Particles are typically decayed biological material, corrosion particles, and paints / pigments.
Fire/combustion residue	Combustion particles including Soot, Char, Ash, and other burned plant or soil material including mineral grains, plant phytoliths, or pollen. Indoor fire residue will also include other plastics, furniture finishes, and construction materials
Anthropogenic/mineral particles	Crystalline soil mineral grains and/or construction materials
Other uncommon particles	Less common particles that may not directly fit the categories described above. These could include copier toner, starch grains, droplet-like particles, specific unique minerals, or corrosion particles.

AIR PROFILE™ AIRBORNE DUST ANALYSIS FLOW DIAGRAM

The EAA ***AIR PROFILE***™ guidelines provide a systematic way of identifying the source of indoor dust complaints using Optical Microscopy and automated SEM / X-ray particle analysis procedures.

Decision Diagram – Based on the statistical percentile frequency of occurrence found in buildings nationwide



Mold / Pollen / Algae

↓

Typical-low <50%	Typical <75%	Atypical 75% - 95%	Elevated >95%
Background		Possible action	Action

Cellulosic/Synthetic fibers

↓

Typical-low <50%	Typical <75%	Atypical 75% - 95%	Elevated >95%
Background		Possible action	Action

Opaque dust

↓

Typical-low <50%	Typical <75%	Atypical 75% - 95%	Elevated >95%
Background	↓	Possible action	Action

Source ID / chemistry / size distribution

Crystalline Mineral Dust

↓

Typical-low <50%	Typical <75%	Atypical 75% - 95%	Elevated >95%
Background / Normal	↓	Possible action	Action

Source ID / chemistry / size distribution

Fire / Combustion residue

↓

Typical-low <50%	Typical <75%	Atypical 75% - 95%	Elevated >95%
Background / Normal	↓	Possible action	Action

Source ID / chemistry / size distribution

Automated Scanning Electron Microscopy (SEM)

↓

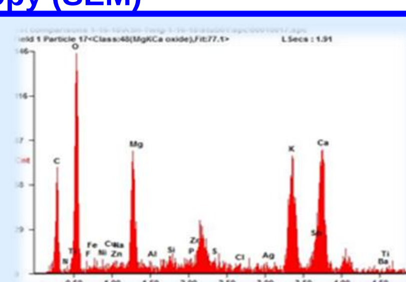
Particle chemistry

↓

Size distribution

↓

Particle ID → **Source identification**



MOLD & FUNGI - ECOLOGY

Elevated mold spore concentrations found in both the indoor and outdoor environment are known to cause allergy symptoms, and are occasionally responsible for respiratory illness in immuno-compromised individuals. Elevated mold spore concentrations in the indoor environment can be caused by outdoor infiltration or from indoor growth sources when elevated surface moisture and humidity are present.

Conditions under which indoor mold growth can occur

- Historical flooding without proper cleanup
- Moisture intrusion occurring through sub-flooring, walls, windows, or roofs
- Plumbing, water line leak, toilet overflows or sewer backups
- Moisture condensation around windows
- Moisture condensation inside HVAC systems
- Persistent elevated relative humidity above 70%, and inadequate housekeeping

Ecology of molds and fungi

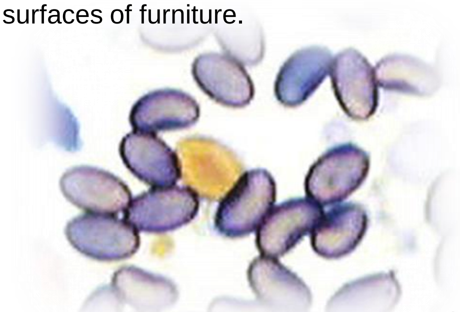
Mold and fungi require three basic criteria to colonize the inside of a building:

- A source of moisture
- A food source
- Lack of surface disturbance and/or air movement

Moisture sources in buildings occur most commonly as water and/or sewer leaks, moisture intrusion through walls and foundations, or as condensation around windows or inside HVAC systems. For example, in some parts of the country such as the southeast United States, the relative humidity during certain times of the year is high enough to act as a significant moisture source on its own.

Indoor food sources for mold can be any organic material provided by a flood, sewer backup, or cellulosic materials present in the building such as carpet backing, linoleum backing, drywall paper, or ceiling panels. The buildup of plant and/or skin cell fragments or debris on inorganic surfaces is also a common source. Skin cell fragments are a significant food and mold colonizing source in office buildings and homes where a high occupancy exists, or adequate housekeeping is not maintained.

Molds colonize most readily where air disturbance is minimal and both the surface and airborne humidity can remain high. For this reason, mold colonization occurs most frequently in closed or concealed spaces such as closets, storerooms, basements, refrigeration units, or on the backside or underside surfaces of furniture.



MOLD & FUNGI – HEALTH EFFECTS

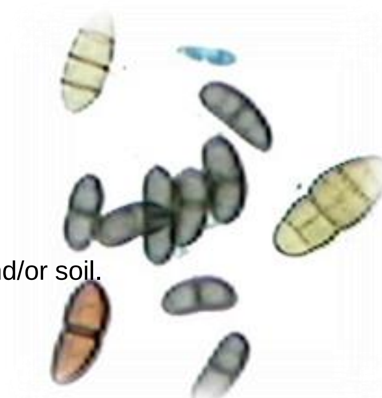
Potential health effects from inhalation of mold and fungal spores:

Based on the existing literature, it is generally accepted in the medical community that exposure to mold may result in symptoms consistent with a cold, flu, allergy hay fever, or asthma in some people. Other individuals may have no symptoms at all. It is generally accepted that there are no long term or permanent health effects from exposure to mold once the occupant is removed from the property, or the "elevated" condition has been corrected. The medical community also generally recognizes that those who are known to be allergic to molds and those with asthma may have a higher risk of allergic reactions and should take extra precautions when in such situations. Laboratory analysis of airborne or surface samples by themselves cannot determine the associated health risks in any specific environment.

Common outdoor molds

Outdoor assemblages of mold spores are most commonly associated with the following genera (listed in approximate order of descending abundance):

- Mushroom-like fungi (Ascospores and Basidiospores)
- Cladosporium
- Alternaria
- Rusts and Smuts (colonizing primary flower and leaf parts)
- Aspergillus & Penicillium (soil and moist cellulosic surfaces).

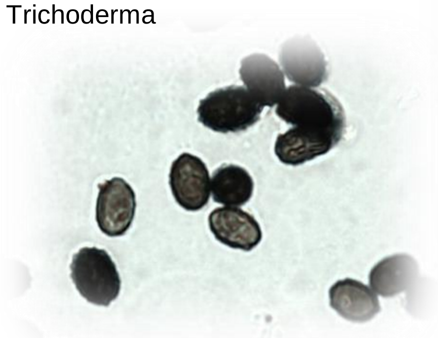


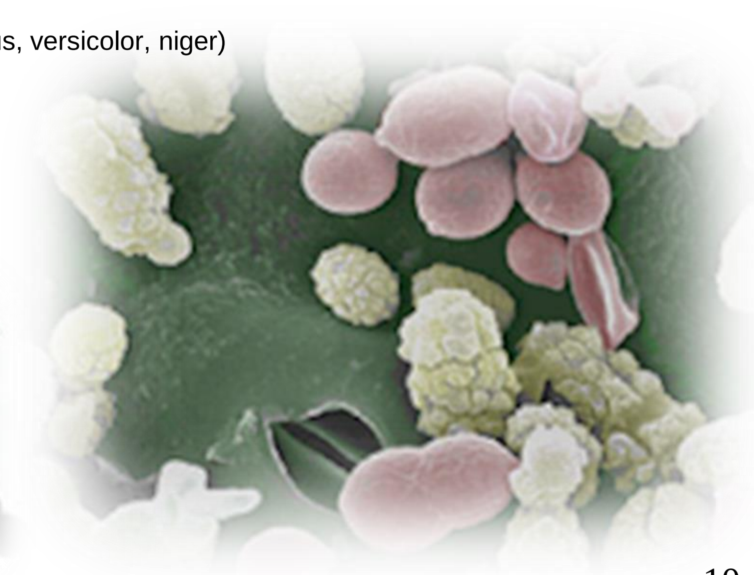
All of the above mentioned mold genera colonize decaying vegetation and/or soil.

Common molds associated with indoor mold "growth"

The most common molds associated with indoor amplification (over 90% of the typical mold growth found inside buildings) given in approximate order of descending abundance are listed below:

- Penicillium sp.
- Aspergillus (flavus, fumigatus, terrus, versicolor, niger)
- Cladosporium
- Chaetomium
- Stachybotrys
- Zygomycetes (Mucor & Rhizopus)
- Ulocladium
- Trichoderma





MOLD & FUNGI – GENERAL AIRBORNE BACKGROUND LEVELS

When chronic moisture intrusion exists, or significant flooding occurs, elevated levels of primary colonizing molds can be present (e.g. Penicillium, Aspergillus, and Cladosporium). Secondary mold growth (e.g. Stachybotrys, Chaetomium, Ulocladium, and Trichoderma) can occur with the presence of chronic moisture. This can also facilitate the colonization of wood-destroying fungi (i.e. Serpula, Poria). Over time, these kinds of fungi can destroy structural wood components of a building and result in very high indoor airborne basidiospore concentrations.

Overview on the interpretation of mold spore concentrations

A high variability in outdoor mold spore concentrations exists on an hourly basis. Levels are dependent on the quantity of local vegetation, the micro-climate, time of year, local weather patterns, and diurnal variation. As a result, caution must be used when simultaneously comparing limited data sets of inside and outside mold concentrations, or over generalizing any set of indoor/outdoor data to desert or snow covered environments. It is also generally accepted that "single-point" comparisons between indoor and outdoor concentrations should not be relied upon as the primary criteria for determining acceptable levels in buildings.

The table given below summarizes the regional geographic outdoor background ranges and the most common conditions associated with elevated indoor mold spore levels. The term "clean" refers to the classification definition of buildings given in our AIHA 2005 Publication entitled "*A Regional Comparison of Mold Spore Concentrations Outdoors and Inside "Clean" and "Mold Contaminated" Southern California Buildings*, 2005, JOEH". The term "clean" used by EAA refers to a building found to have no evidence of historical water intrusion and no visible evidence of elevated moisture conditions or mold growth determined by a systematic and thorough visual inspection. This paper is also available on the "News and Information" page of the EAA website.

Typical Outdoor Mold Spore Concentration Ranges and Genera

			Mold Genera and Prevalence				
Description / Condition	Spores (cts/m^3)		As/ba	Cla	Oth	As/Pe	W.I.
Arid / desert regions	50 -	5,000	C	C	C	L	T
Urban & coastal strip	200 -	30,000	C	C	C	L	T
Inland valley / native vegetation	500 -	50,000	P	P	C	L	T
Farms & heavy forestation	5,000 -	100,000	P	P	C	L	L

Typical Indoor Mold Spore Concentration Ranges

"Clean" non-HVAC supplied air	ND -	1,600	C	C	C	L	T
"Clean" HVAC supplied air	ND -	500	L	L	L	L	T
Low - elevated, infiltration, pos. growth	600 -	13,000	L	C	L	C	L
Moderate – Growth likely	13,000 -	50,000	L	C	L	P	L
High - Growth	>50,000		C	C	L	P	C
Inadequate flood cleanup/demolition	>50,000		C	C	C	P	C

Genera present

As/Ba – Asco / basidiospores
Cla – Cladosporium
Oth – Other (Alternaria, Dreschlera, Rusts, Smuts, etc.)
As/Pe – Aspergillus and/or Penicillium species
W.I. – Water Indicating - including (Stachybotrys, Chaetomium, Ulocladium, Trichoderma)

Genera Distribution / Concentration

ND – Not detected
P - Predominant (can comprise ~80% of the spore distribution)
C – Commonly occurring (can comprise ~50% of the spore distribution)
L - Low (comprises <10% of the spore distribution)
T – Trace (comprises <5% of the spore distribution)

USING THE EAA ***AIR PROFILE***™ GUIDELINES

Environmental Analysis Associates provides concise and understandable laboratory reports for the classification of airborne and mold, and indicator dust categories. ***AIR PROFILE***™ **is a** trade-marked data interpretation systems used by Environmental Analysis Associates, Inc. The particle category and measured concentrations are systematically classified in a format that helps investigators determine if the *dust profile* is likely generated by occupant activity, moisture intrusion, building renovation activities, HVAC system corrosion, furnishings, and/or the infiltration of outdoor dust. Interpretation guidelines and color-coded data summary comparison tables are provided (in addition to the laboratory reports) that can easily be added into your own site inspection reports.

These guidelines provide an updated color-coded airborne exposure summary page that is based on the statistical analysis of air samples analyzed by our own laboratory during the years of 2017-2018. This database consists of over 3,500 indoor and 1.500 outdoor samples collected nationwide. The enhanced guidelines integrate color-coded classifications representing specific statistical concentration ranges. The percentile frequency of occurrence is used as a way to compare your airborne data measurements with the range of concentrations measured inside other buildings that are unrelated to your project. The statistical ranges used by EAA are described below:

Elevated-6	**>99th - percentile frequency of detection (Highest 1% of all measurements)** **Buildings with indoor generating sources and/or significant infiltration**
Elevated-5	**95th - 99th percentile frequency of detection (Highest 5% of all measurements)** **Buildings with indoor generating sources and/or atypical infiltration**
Atypical-4	**90th - 95th percentile frequency of detection (Highest 10% of all measurements)** **Possible generating sources, infrequent cleaning, and/or inadequate filtration**
Atypical-3	**75th - 90th percentile frequency of detection (Highest 25% of all measurements)** **Possible infrequent cleaning, low filtration, and/or high occupancy**
Typical-2	**50th - 75th percentile frequency of detection (50% of samples above the median)** **Average building**
Typical-1	**<50th - percentile frequency of detection (50% of samples below the median)** **Average "clean" non-impacted building**

In most particle classifications, levels defined as "Elevated" at the 95th percentile were found to be ~5-10 times higher than the "Typical" 50th percentile levels.

INDOOR AIRBORNE CLASSIFICATION GUIDELINES

Approximate Percentile Concentration Thresholds (Cts/m^3) - Based on the EAA nationwide database

Classification	Percentile	Total Mold	Asp / Pen	Chronic * W.I. Mold	Outdoor Mold	Algal Fern	Insect Parts	Pollen	Skin Cell Frag.	Fiber-glass	Cellulose **/ Syn Fibers	Opaque Dust	Mineral Dust		*** Fire Residue
Elevated - 6	>99th	>40000	>22000	>240	>16000	>950	>1000	>40	>30000	>650	>5900	>41000	>132000		No data
Elevated - 5	>95th	>12000	>3500	>100	>8000	>500	>500	>13	>15000	>90	>1800	>13000	>41000	10 x bkg.→	>1000
Atypical - 4	>90th	>6000	>1000	>50	>5000	>240	>180	>7	>10000	>30	>1100	>7800	>22000		
Atypical - 3	>75th	>1600	>140	>20	>1500	>140	>60	>7	>6000	>8	>600	>3700	>9000	3x bkg.→	>300
Typical - 2	>50th	>400	>18	>11	>360	>90	>60	>3	>3050	>4	>290	>1800	>4400		>100
Typical - 1	<50th	<400	<18	<11	<360	<90	<60	<3	<3050	<4	<290	<1800	<4400	bkg. → (2x d.l.)	<100

Note: The calculated data shown on page 9 has been rounded "up" to 3 decimal places to define each exposure classification range

* *W.I. = Water indicating, ** Syn = Synthetic*

**** Preliminary fire particle data is in a separate database of non fire complaint related buildings. Because of the high percentage of measurements found below the limit of detection (~40%), the comparison guidelines are based on the differential above a value of twice the method detection limit (d.l.). Atypical and Elevated classifications are defined as 3 and 10 times the background (bkg) respectively.*

d.l. = 50cts/m^3

USING THE EAA ***DUST PROFILE***™ GUIDELINES

Environmental Analysis Associates provides concise and understandable laboratory reports for the classification of surface mold, and indicator dust categories. ***DUST PROFILE***™ is a trade-marked data interpretation system used by Environmental Analysis Associates, Inc. The particle category and measured concentrations are systematically classified in a format that helps investigators determine if the *dust profile* is likely generated by occupant activity, moisture intrusion, building renovation activities, HVAC system corrosion, furnishings, and/or the infiltration of outdoor dust. Interpretation guidelines and color-coded data summary comparison tables are provided (in addition to the laboratory reports) that can easily be added into your own site inspection reports.

These guidelines provide a color-coded surface dust summary page that is based on the statistical percentile analysis of surface samples analyzed throughout the United States by our own laboratory during the years of 2015-2019. This database consists of over 500 tape lift surface samples collected from “Typical” buildings and 150 “Problem” buildings. The percentile frequency of occurrence is used to compare your airborne data measurements with the range of concentrations measured inside other buildings. The statistical ranges used by EAA are described below:

Elevated-6 — **99th - percentile frequency of detection (Highest 1% of all measurements)**
Buildings with indoor generating sources and/or significant infiltration

Elevated-5 — **95th - percentile frequency of detection (Highest 5% of all measurements)**
Buildings with indoor generating sources and/or atypical infiltration

Atypical-4 — **90th - 95th percentile frequency of detection (Highest 10% of all measurements)**
Possible generating sources, infrequent cleaning, and/or inadequate filtration

Atypical-3 — **75th - 90th percentile frequency of detection (Highest 25% of all measurements)**
Possible infrequent cleaning, low filtration, and/or high occupancy

Typical-2 — **50th - 75th percentile frequency of detection (50% of samples above the median)**
Average / typical building

Typical-1 — **<50th - percentile frequency of detection (50% of samples below the median)**
Average "clean" non-impacted building

CLASSIFICATION GUIDELINES - Average Residential and Commercial Buildings (Particles / mm²)

Database of over 500 surfaces samples collected in "Typical" Buildings							~ 150 "Problem" Building Samples		
Classification	*Percentile Ranking	Total Mold Spores	Aspergillus/ Penicillium	Chronic Water Indicating	Typical Outdoor Molds	Hyphae Fragments	Total Mold Spores	Aspergillus/ Penicillium	Hyphae Fragments
Elevated - 6	>99%	>40	>6.0	>1.0	>30	>3.0	>20000	>17000	>2000
Elevated - 5	>95%	>10	>1.0	>0.2	>7.0	>1.0	>4100	>2000	>700
Atypical - 4	>90%	>5.0	>0.10	>0.10	>4.0	>0.70	>2000	>260	>120
Atypical -3	>75%	>2.0	>0.05	>0.01	>1.0	>0.05	>45	>0.1	>3.0
Typical - 2	>50%	>0.2	>0.01	>0.001	>0.10	>0.02	>4.0	>0.01	>0.02
Typical - 1	<50%	< 0.2	<0.01	< 0.001	<0.10	<0.02	<4.0	<0.01	<0.02
Frequency of detection		63%	9%	1%	63%	20%	83%	25%	38%

CLASSIFICATION GUIDELINES - Average Residential and Commercial Buildings (Particles / mm²)

Database of over 500 surfaces samples collected in "Typical" Buildings

Classification	Approximate Percentile Ranking	Pollen	Skin Cell Fragments	Fiberglass	Cellulose / Synthetic Fibers	Unidentified Opaque	Soil / Crystalline Minerals	*Suspect problem Buildings Only* Fire Residue	* Other
Elevated - 6	>99%	>10	>260	>3.0	>75	>700	>900	>3360	
Elevated - 5	>95%	>2.0	>150	>1.0	>50	>130	>240	>1680	> 50
Atypical - 4	>90%	>1.0	>110	>0.7	>25	>60	>140	>388	>25
Atypical -3	>75%	>0.3	>35	>0.1	>10	>20	>60	>4.0	>10
Typical - 2	>50%	>0.0	>12	>0.03	>3.0	>7.0	>15	>0.04	>3.0
Typical - 1	<50%	<0.04	<12.0	<0.03	<3.0	<7.0	<15	<0.04	<3.0
Frequency of detection		33%	96%	26%	93%	98%	99%	Not measured	

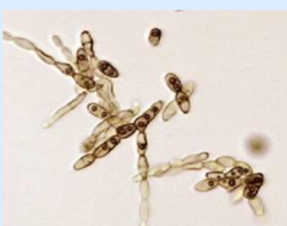
MOLD & FUNGI – INDOOR GUIDELINES

Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Outside	Variable by season	0.1 – 200		ND – 200,000
Elevated - amplification possible	Elevated - 6	> 40	$>99^{th}$	* >40,000
Elevated mold present	Elevated - 5	* > 10	$>95^{th}$	* >12,000
Atypical - possible source	Atypical – 4	* > 5	$>90^{th}$	* > 6,200
Atypical – marginally elevated	Atypical - 3	* > 2	$>75^{th}$	* > 1,600
Inside air "typical" residential	Typical - 2	> 0.2	$>50^{th}$	* > 400
Inside air "clean" HVAC buildings	Typical - 1	< 0.2	$<50^{th}$	* < 400

** Depends upon the genera / species present*

The upper range of <u>total</u> mold spore concentrations in a typical building (i.e. 75^{th} percentile) is approximately 1,600 cts/m^3 with an average (50^{th} percentile) of 400 cts/m^3. Aspergillus /Penicillium spores (see previous page) have an upper range (75^{th} percentile) of 140 cts/m^3 with an average (50^{th} percentile) of ~40 ct/m^3. Aspergillus/Penicillium spore concentrations above the 90^{th} percentile of 1,000 cts/m^3 (High) should be considered to be elevated. Stachybotrys, Chaetomium, and Ulocladium (potential indicators of chronic surface moisture) are often recovered in low concentrations in indoor samples as a result of normal infiltration. Therefore, detection in low concentrations does not necessarily indicate an indoor growth source. Because there is no direct relationship between simultaneously collected indoor and outdoor samples, performing a direct comparison without outdoor data should only be used as a "positive" control to determine if the outdoor environment is contaminating the indoor environment. Outdoor levels are not a reliable "baseline" control for "acceptable" indoor spore levels.

Mold spores commonly found outdoors and indoors

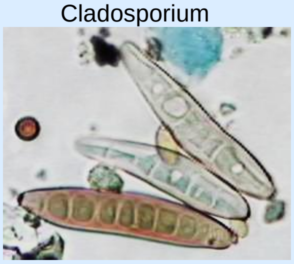


Cladosporium

Ascospores

"Poria" dry rot spores

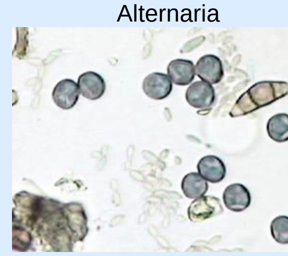
Alternaria



Bipolaris-like

Epiccocum

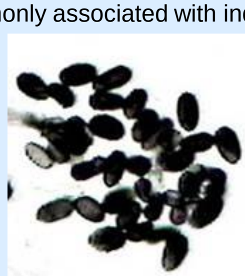
Curvularia



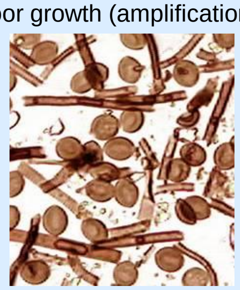
Smut-like

Mold spores most commonly associated with indoor growth (amplification)

Penicillium/Aspergillus

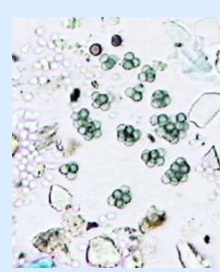


Stachybotrys



Chaetomium

Pithomyces / Ulocladium



Trichoderma

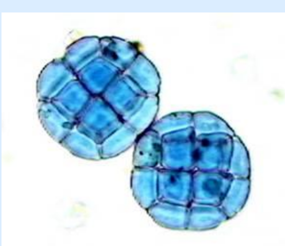
POLLEN / FERN SPORES

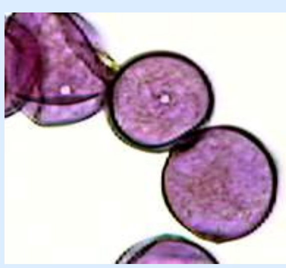
Description	Classification-Level	Surface (cts/mm^2)	Percentile	Airborne (cts/m^3)
Outside	Variable by season	0.1 – 100		0.5 – 3,000
Elevated - infiltration present	Elevated - 6	> 10	> 99th	> 40
Elevated - Infiltration possible	Elevated - 5	> 2.0	>95th	> 35
Atypical – low infiltration	Atypical - 4	> 1.0	>90th	> 16
Atypical - present	Atypical - 3	> 0.3	>75th	> 8
Inside (Low-typical)	Typical - 2	> 0.1	>50th	> 4
Inside Low	Typical - 1	< 0.1	<50th	< 4

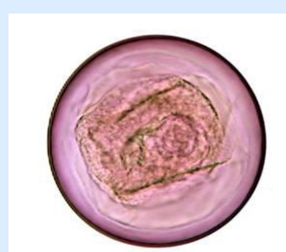
The presence of pollen or fern spores in the indoor environment is almost always the result of outdoor air infiltration. In a typical HVAC air supplied building, airborne pollen concentrations will be very low (less than ~16 ct/m^3) or not detected at all. Sensitive individuals can mistakenly attribute complaints to the interior of a building that are actually the result of exterior infiltration or other allergen sources. Landscaping in building courtyards can also be a factor with perceived indoor problems. The time of year, the home environment, and pathway to work, may also be significant sources for potential exposure.

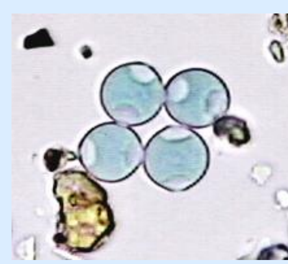
According to the medical literature, the individual allergy response to pollen exposure is highly variable. Some individuals with pollen allergies may begin to exhibit symptoms when airborne concentrations exceed approximately 50 cts/m^3, especially with grass or highly allergenic pollen such as ragweed. Outdoor airborne levels can range from not detected to over 3,000 cts/m^3 depending on the geographic location, local vegetation, and season. The time of day when symptoms are pronounced is extremely critical for proper source diagnosis. Because of the wide range and severity of individual pollen allergies, consultation with an Allergist may be warranted in the rare occasions where elevated indoor pollen concentrations have been measured.

Pollen identification in the EAA analysis report is given as the genus when known, or as the taxonomic classification (e.g. inaperturate, triporate, tricolpate, etc.) when the pollen cannot be readily identified. Detailed speciation of pollen is only provided upon special request.


Acacia

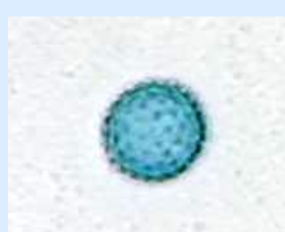

Grass

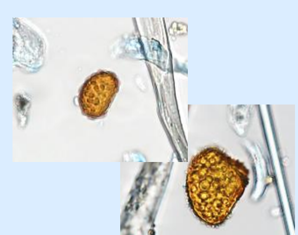

Fir


Betula (Birch)


Tricolporate (classification)


Pinus-like


Ragweed


Fern spores

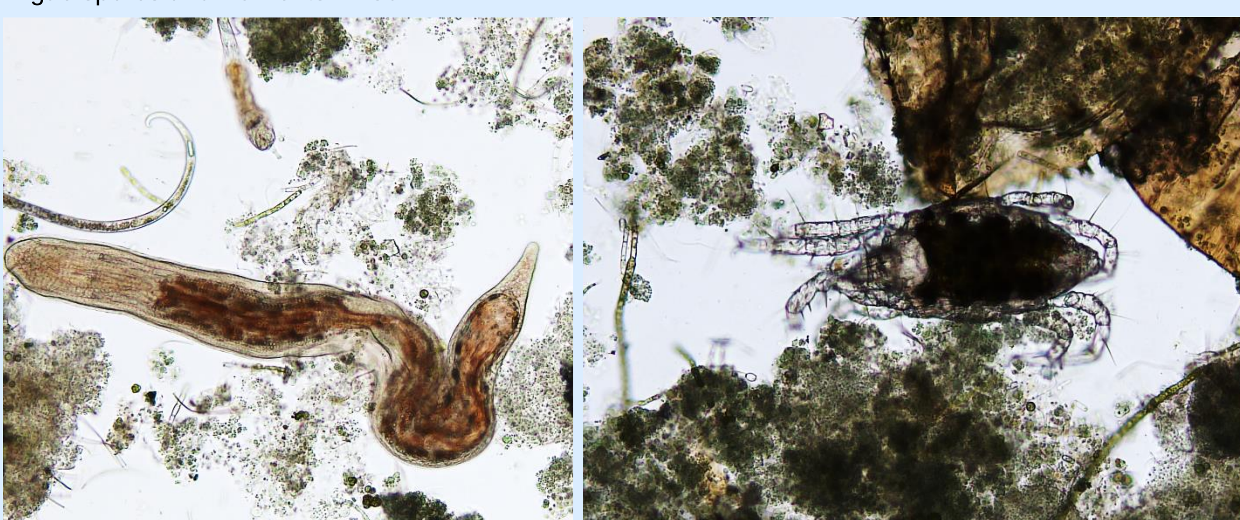
ALGAE, MITES, & OTHER ORGANISMS

Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Elevated-source likely	Elevated - 6	NA	>99th	> 950
Elevated-source possible	Elevated - 5	> 0.5	>95th	> 500
Atypical – source possible	Atypical - 4	> 0.3	>90th	> 240
Atypical – source possible	Atypical - 3	> 0.1	>75th	> 140
Typical background	Typical - 2	< 0.1	>50th	> 100
Typical low background	Typical - 1	Not measured	<50th	< 100

Note: Values are estimates due to the low frequency of occurrence

When algae, bio-film deposits, protozoan organisms, etc. are detected in any concentration in indoor samples, a stagnant or chronic water source is likely present. Although significant information is not readily available regarding health effects, algae and bio-film organisms are potential indicators of persistent moisture and other potential bacteriological or protozoa reservoirs.

Algae spores and filaments – 750x



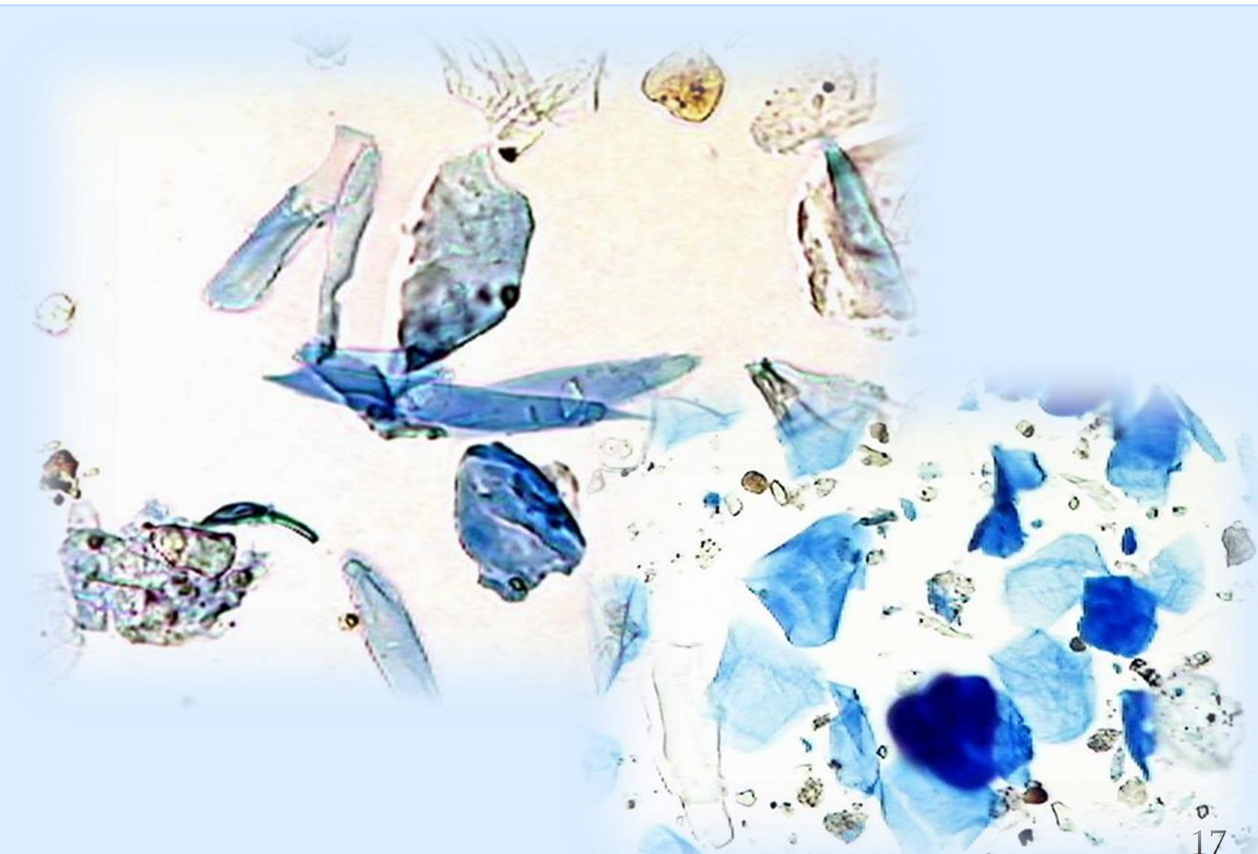
Bio-film organisms and decayed debris associated organisms – 100x

SKIN CELL FRAGMENTS – (DANDER)

Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Outside	Low range	<0.1		7 - 1,000
Elevated - high activity	Elevated - 6	>260	>99th	>30,000
Elevated – moderate activity	Elevated - 5	>150	>95th	>15,000
Atypical - moderate activity	Atypical - 4	>110	>90th	>10,000
Atypical - marginally elevated	Atypical - 3	> 35	>75th	> 6,000
Typical background	Typical - 2	> 12	>50th	> 3,000
Typical low background	Typical - 1	< 12	<50th	< 3,000

Dander or skin cell fragments are the most common source of particle debris in indoor samples. The skin cell fragment category includes particle concentrations greater than ~20µm in diameter. One of the biggest differences between inside and outside air quality is the high concentration of skin cell fragments and human-borne contaminants (i.e. bacteria, viruses) found indoors riding as passengers on skin tissue. Skin fragments often comprise over 50% of the volume of identifiable particles in indoor air. It is not possible in a microscopic analysis to routinely differentiate human dander from animal or pet dander.

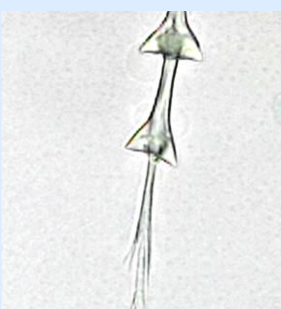
Although no direct health effects can be derived by their measurement, skin cell fragment concentrations are a good surrogate indicator of the total impact of occupant density, commensal bacteria potential, housekeeping cleaning practices, and the filtration of recirculated air in the building.

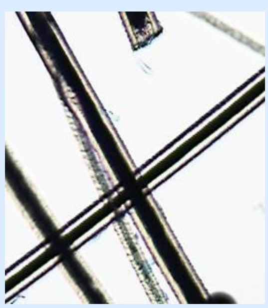


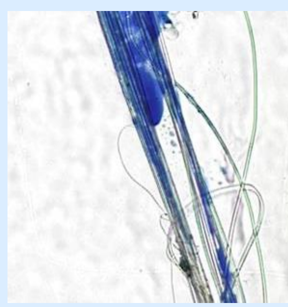
BIOLOGICAL, CELLULOSIC, & SYNTHETIC FIBERS

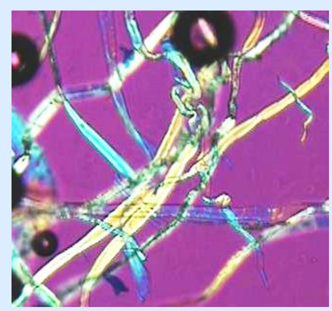
Description	Classification-Level	Surface Cts/mm²	Percentile	Airborne Cts/m³
Outside--(Usually plant fragments)	Variable	0.1 - 5.0		100 - 1,000
Elevated - active source	Elevated - 6	> 75	>99th	>5,900
Elevated - source possible	Elevated - 5	> 50	>95th	>1,800
Atypical - moderate activity	Atypical - 4	> 25	>90th	>1,000
Atypical - moderate activity	Atypical - 3	> 10	>75th	> 600
Typical background	Atypical - 2	> 3	>50th	> 300
Typical - low background	Atypical - 1	< 3	<50th	< 300

The cellulosic / synthetic fiber category covers a wide range of carbonaceous fibers that are commonly found in indoor samples. Fibers in this category include biogenic fibers (derived from biological activity, e.g. leaf and twig fragments, trichomes, spider web silk, vegetation fibers, hair/fur, feather fibrils), clothing fibers (cotton and synthetic fabrics), and nylon carpet fibers. Indoor fiber emission sources can include architectural finishes, cellulose insulation, and other paper products. These fibers for the most part are anisotropic (crystalline), and will appear yellow and/or blue depending on their orientation when examined using a polarized light microscope with a full wave plate inserted. Some synthetic fibers will appear yellow in all orientation directions, that is, the same light vibration in all directions. Biogenic fibers generated from biological sources (plant, insect, or animal) by themselves are not normally a cause of allergy or illness symptoms. Elevated biogenic and fabric fibers may be an indication of inadequate housekeeping, ventilation, high biogenic sources, and/or high occupancy rates.

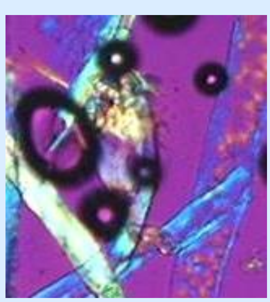

Down feather fibril

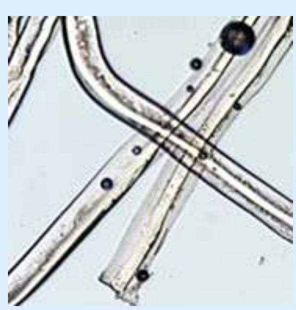

Dog hair


Spider web


"Kleenex" tissue (PLM)


Cardboard (BF)


Cardboard (PLM)


Nylon carpet (BF)


Nylon carpet (PLM)

FIBERGLASS FIBERS

Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Elevated-source present	Elevated - 6	> 3	>99th	> 650
Elevated-source possible	Elevated - 5	> 1	>95th	> 90
High activity	Atypical - 4	> 0.7	>90th	> 30
Marginal potential source	Atypical - 3	> 0.1	>75th	> 8
Typical background	Typical - 2	> 0.03	>50th	> 4
Typical low background	Typical - 1	< 0.03	<50th	< 4

Fiberglass fibers are composed of amorphous (non-crystalline) fibrous glass particles and are most commonly found in insulation products. Fibrous glass sources may include thermal or sound insulation, ceiling tiles, debris from renovation projects, or the degradation of HVAC system sound dampening insulation inside the ventilation ducting system.

Because "fiberglass" and mineral wool are manufactured by different processes, they are morphologically different but may be chemically similar. Fiberglass fibers are uniform along the entire width of the fiber, while mineral wool is characterized by non-uniform width and the presence of bulbous and rounded ends. Both fiber categories are isotropic (non-crystalline) and by definition the refractive index does not change with orientation. As a result, fiberglass fibers when viewed in cross-polarized light become invisible without the use of a retardation (full) wave plate in addition to polarized light. When a full wave retardation plate is inserted, these fibers will appear colorless in all orientations.

The macroscopic coloration of bulk insulation (e.g. yellow, pink, black) is due to the resin binder holding the insulation together and not the color of the glass fiber. All fibrous glass fibers are typically colorless. The source and location of fiberglass insulation in a building can sometimes be differentiated by the resin droplet color used as a binding material on the glass fiber itself.

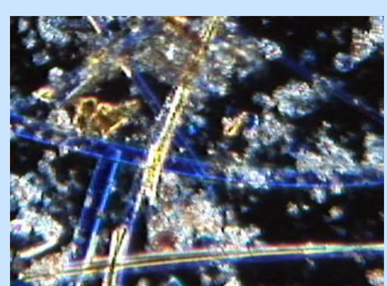
Black sound liner fiberglass

Yellow "batt" insulation

Pink "batt" insulation

Yellow duct wrap insulation

Mineral wool – ceiling tile



Fiberglass (PLM-dispersion staining)

OPAQUE PARTICLES OVERVIEW

Initial analysis is performed by Optical Microscopy. Automated SEM analysis may be required to identify the exact composition of the dust and to identify the most likely source.

Description	Classification-Level	Surface Cts/mm²	Percentile	Airborne Cts/m³
Elevated - source present	Elevated - 6	> 700	>99th	>41,000
Elevated - source possible	Elevated - 5	> 130	>95th	>13,000
Atypical - Infiltration / source possible	Atypical – 4	> 60	>90th	> 8,000
Atypical - low-moderate dust	Atypical - 3	> 20	>75th	> 4,000
Typical background	Typical - 2	> 7	>50th	> 1,800
Typical – low background	Typical - 1	< 7	<50th	< 1,800

The opaque particle category encompasses a wide range of unrelated biological and anthropogenic (man-made) particles that appear to be brown or black when observed using transmitted light microscopy. These optically opaque particles may visually be other colors to the naked eye or when examined using reflected light microscopy. These particles often require the use of Reflected Light Dark Field microscopy, and/or SEM / X-ray analysis to identify the type, chemistry, or origin the particle. Commonly occurring optically opaque particles are generated from five major processes including:

1. Infiltration of optically opaque occurring soil particles, biological debris, asphaltic debris, and tire rubber
2. Biological / biogenic decay – Decayed skin cells, bio-films, insect droppings, oil residues
3. Corrosion – Degradation of metal HVAC components, pipes, paint, pigments
4. Friction/abrasion – Materials released as result of HVAC component vibration and moving parts
5. Combustion – Burning and heating of biogenic, organic, and other combustible materials

Note: In order to differentiate "fire residue particles" from general opaque particles, additional sub-analysis must be requested.

Micrographs of these various types of opaque particles are given on the following pages.

The most common outdoor sources of "opaque" or black/brown particles are soil, decayed vegetation, automobile emissions, insect droppings, and generally very low concentrations of fire residue particles.

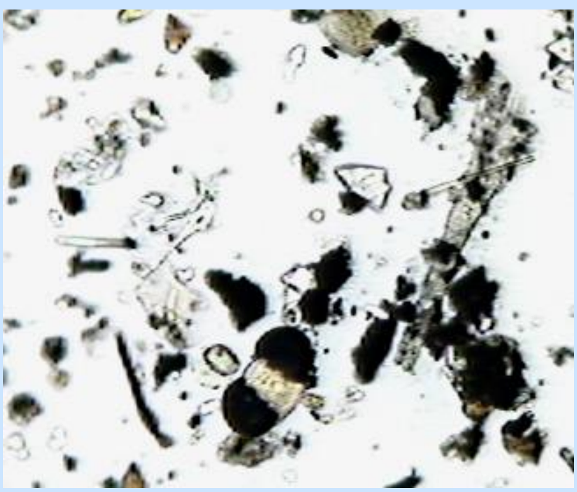
The most common indoor generated particles include paint, binders from degrading sound liners in HVAC systems, biogenic debris (biological origin, e.g. insect droppings, decayed biological debris, etc.), fan belt rubber particles, oil residue/dust agglomerates, copier toner, corrosion from HVAC components and metal ducting, and occasionally combustion emissions (soot & char). Determining the particle chemistry and the generating source usually requires additional analysis by automated Scanning Electron Microscopy (SEM) / X-ray analysis. The airborne concentration of total "opaque" particles does not normally occur in concentrations exceeding approximately 10,000 cts/m³ in "clean" indoor environments. Identification of the particle origin is not always possible, however, should be investigated as a possible contributor to air quality complaints when airborne concentrations exceed ~16,000 cts/m³.

From a morphological standpoint, biologically derived opaque particles can often be separated from other types of opaque particles. In some cases opaque particles cannot be morphologically differentiated from corrosion shedding particles without using additional analysis by Scanning Electron Microscopy / X-ray or chemical analysis.

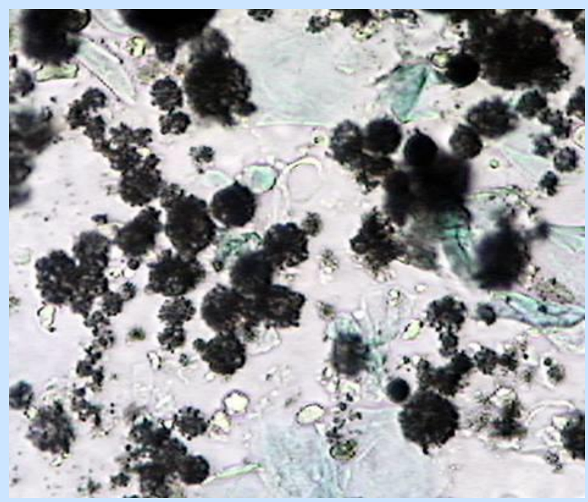
OPAQUE PARTICLES (Primarily biogenic)

Description	Classification-Level	Surface Cts/mm²	Percentile	Airborne Cts/m³
Elevated - source present	Elevated - 6	> 700	>99th	>41,000
Elevated - source possible	Elevated - 5	> 130	>95th	>13,000
Atypical - building infiltration likely	Atypical - 4	> 60	>90th	> 8,000
Atypical - low-moderate dust	Atypical - 3	> 20	>75th	> 4,000
Typical background	Typical - 2	> 7	>50th	> 1,800
Typical - low background	Typical - 1	< 7	<50th	< 1,800

Biogenic opaque black or brown debris are derived from the chemical or micro-biological decomposition of organic debris. The most common indoor sources are decayed soil vegetation, mold, dander, insect droppings, etc. From a morphological standpoint, biologically derived opaque particles can often be separated from other types of opaque particles. Most biogenic debris have irregular, rounded, and "fuzzy" edge definition and lack the presence of straight particle edges, cleavage planes, or fracture marks. They also have a variability in optical density and will show an irregular variation in color and/or light transmission on the edges of, and/or throughout the particle. Examples of high levels of airborne biogenic derived debris (i.e. >100,000 cts/m³) are given below:

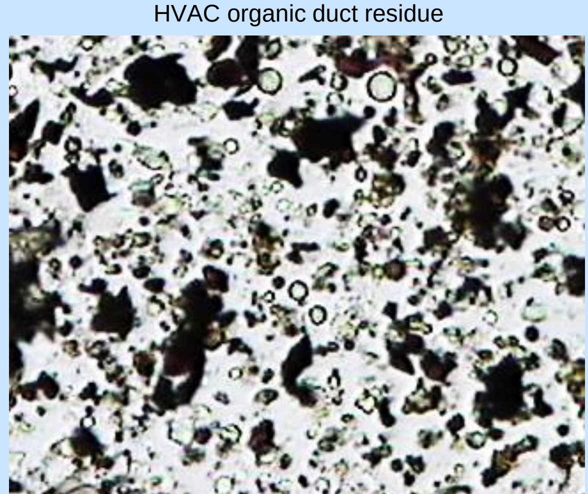


Outdoor plant/soil debris & insect droppings



HVAC organic duct residue

Decaying fungal debris



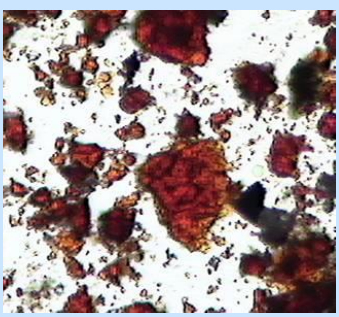
Floor sweepings from a garage

OPAQUE PARTICLES (Corrosion & friction)

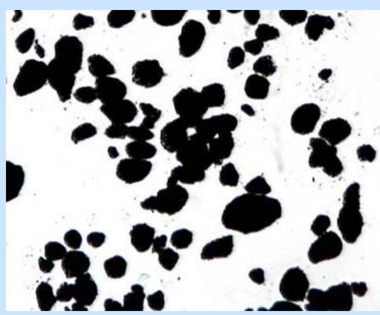
Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Elevated - source present	Elevated - 6	> 700	>99th	>41,000
Elevated - source possible	Elevated - 5	> 130	>95th	>13,000
Moderate - building infiltration likely	Atypical - 4	> 60	>90th	> 8,000
Low-moderate dust	Atypical - 3	> 20	>75th	> 4,000
Typical background	Typical - 2	> 7	>50th	> 1,800
Typical – low background	Typical - 1	< 7	<50th	< 1,800

Man-made and opaque corrosion particles are derived from chemical or physical degradation, corrosion, and shedding of mineral, resinous, bituminous, or rubber debris (tire rubber, motor belts). The most common indoor sources are metal corrosion (Aluminum, Zinc, Iron) from HVAC system components, or pigment and paint shedding from building surfaces. These types of opaque particles can often be separated from other sources by using a combination of transmitted and reflected light microscopy. Exact identification and quantification may require SEM and X-ray elemental analysis.

Most non-biogenic opaque particles have angular and distinct edges, and a low variation in optical density from the edge to the center of the particle in transmitted light illumination. They can often be identified or classified based on the characteristic surface pitting structure using reflected light (dark field) microscopy (see bottom picture of HVAC corrosion).

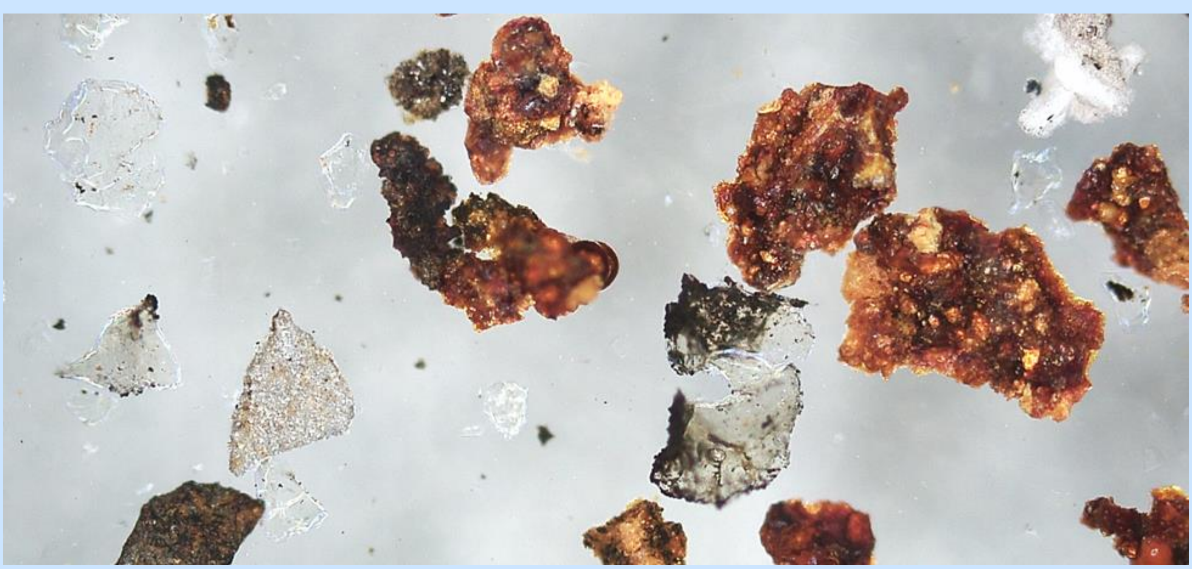


Iron rust particles



Copier toner

Tire rubber particles

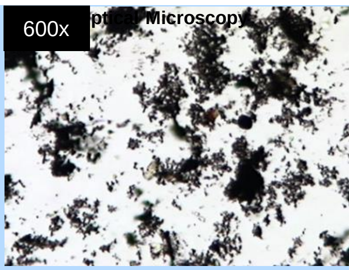


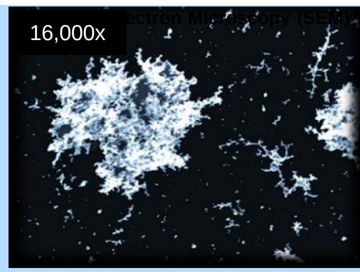
HVAC system corrosion particles (Aluminum, Iron, and Zinc oxide particles)

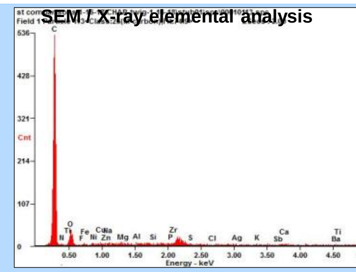
COMBUSTION RESIDUE (Wildfire & Structure Fires)

Description	Classification-Level	Surface Ratio %	Surface Cts/mm^2	Percentile	Airborne cts/m^3
Elevated- source present	Elevated - 6	NA	NA	>99th	Insufficient background data
Elevated-source possible	Elevated - 5	>10 %	> 50	>95th	10x bkg. > 1,000
Atypical-source possible	Atypical - 4	> 5 %	> 10	>90th	
Atypical - marginal	Atypical - 3	> 3 %	> 5	>75th	3x bkg. > 300
Typical background	Typical - 2	> 1 %	> 1	>50th	1x bkg. > 100
Typical - low background	Typical - 1	< 1 %	< 1	<50th	< 100

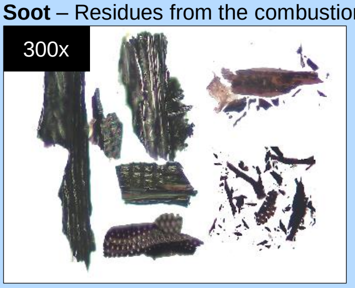
Combustion particles can be separated into three morphological categories (soot, char, and ash). There are also other indicator particles that can assist in the differentiation of wildfire and structure fire residues from other types of combustion sources. Wildfire combustion particles are a complex mixture of cellulose vegetation, burned soil, residual salts, and crystalline calcium and silica vegetation particles (phytoliths). Structure fires have a different particle distribution, typically with higher ratios of soot particles and other melted plastics, paint, and metals. Quantifying airborne and surface fire combustion contamination is a multi-step process requiring Optical Microscopy (Reflected Light, Bright Field and Polarized Transmitted Light). Automated Scanning Electron Microscopy/X-ray analysis can be utilized to help differentiate look-alike interference particles from actual combustion residue or confirm the "ash" chemistry.

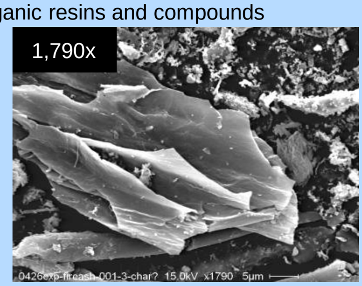


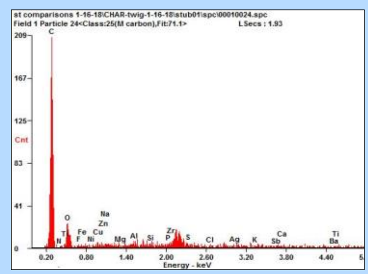




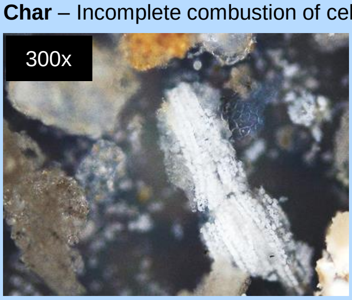
Soot – Residues from the combustion of organic resins and compounds

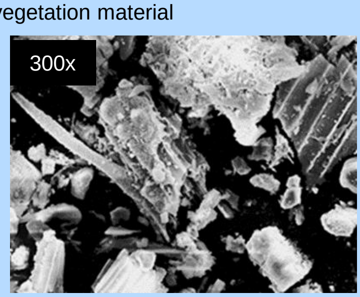


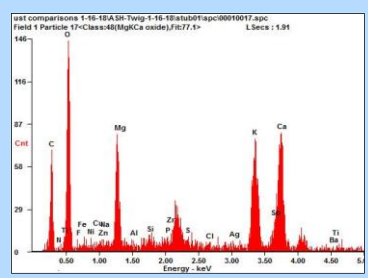




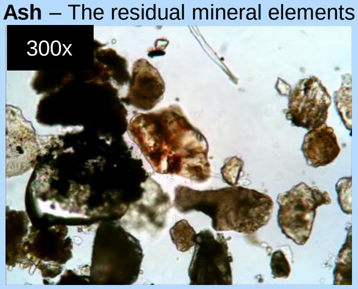
Char – Incomplete combustion of cellulose vegetation material



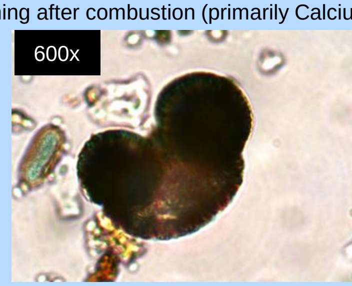




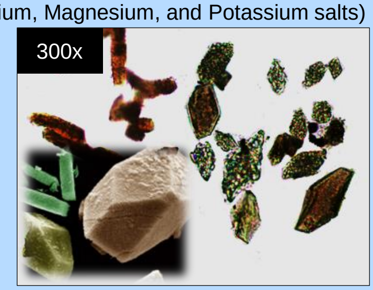
Ash – The residual mineral elements remaining after combustion (primarily Calcium, Sodium, Magnesium, and Potassium salts)



Wildfire Indicator
Burned/carbonized mineral grains



Wildfire Indicator
Burned pollen



Wildfire Indicator
Burned oak tree phytoliths

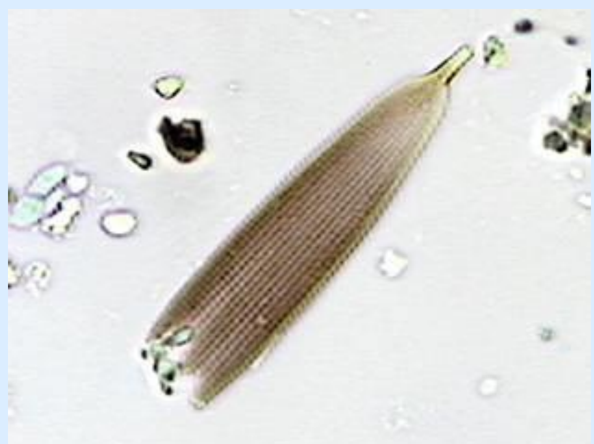
INSECT PARTS

Description	Classification-Level	Surface Cts/mm^2	Percentile	Airborne Cts/m^3
Elevated–source possible	Elevated - 6	NA	>99th	> 1000
Elevated-atypical levels present	Elevated - 5	> 10.0	>95th	> 500
Atypical	Atypical - 4	> 5.0	>90th	> 200
Atypical - marginal	Atypical - 3	> 1.0	>75th	> 100
Typical background	Typical - 2	> 0.1	>50th	> 60
Typical - low background	Typical - 1	< 0.1	<50th	< 60

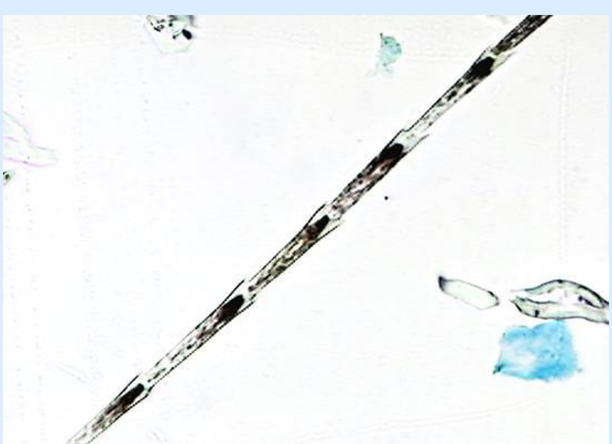
Note: Values are estimates due to the low frequency of occurrence

Recognizable insect parts can be comprised of whole insects or fragments (e.g. body parts, antennae, legs, scales, body hairs, and wing fragments). In clean indoor environments, insect parts are occasionally detected, however, airborne concentrations above ~100 cts/m^3 in air samples are not routinely measured. Elevated concentrations of wings scales, body parts, or insect droppings found in airborne or surface samples may be an indicator of an infestation or inadequate building maintenance and/or air filtration. Occasionally dust mites are also found when inadequate housekeeping, high moisture levels, or extensive mold growth is present. Moderate to high concentrations of dust or carpet mites, or parts of other types of organisms in surface or airborne samples may indicate a possible infestation.

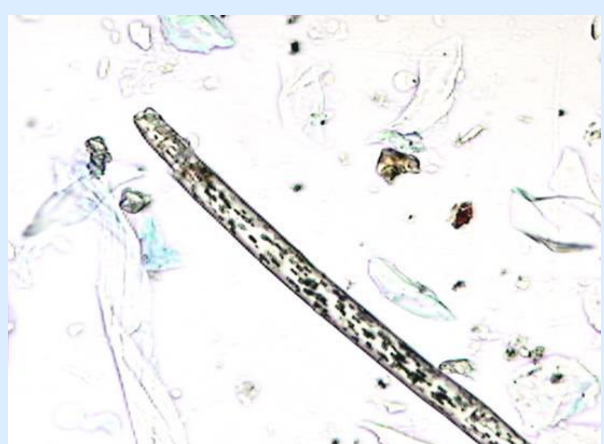
Dust & carpet mites



Moth wing scale



Insect body hair



Insect body hair

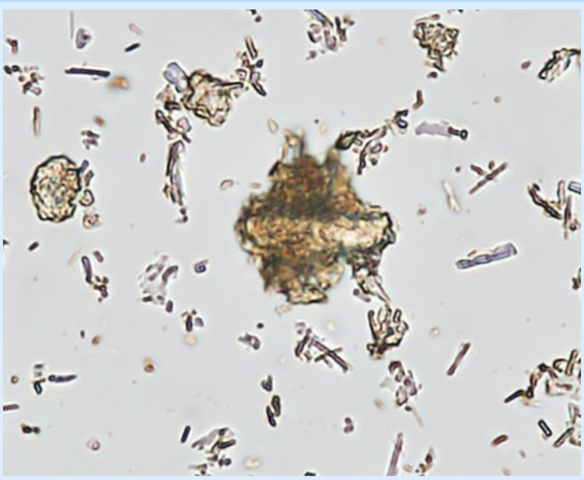
CRYSTALLINE MINERALS – Soil / construction dust

Description	Classification-Level	Surface Cts/mm²	Percentile	Airborne Cts/m³
Elevated source likely present	Elevated - 6	> 900	>99th	> 132,000
Elevated source possible	Elevated - 5	> 240	>95th	> 41,000
Atypical - moderate dust source	Atypical - 4	> 140	>90th	> 22,000
Atypical - low-moderate dust source	Atypical - 3	> 60	>75th	> 9,000
Typical background	Typical - 2	> 15	>50th	> 4,000
Typical – low background	Typical - 1	< 15	<50th	< 4,000

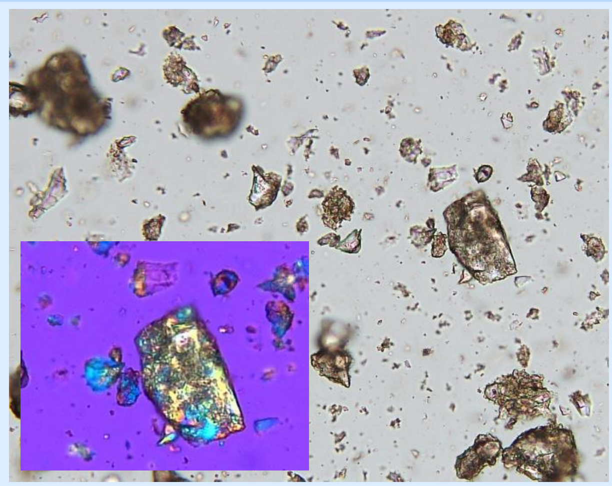
Crystalline mineral particles found indoors are generated by two primary sources:

1). Infiltrated and naturally occurring soil particles and,
2). Building construction and finish materials.

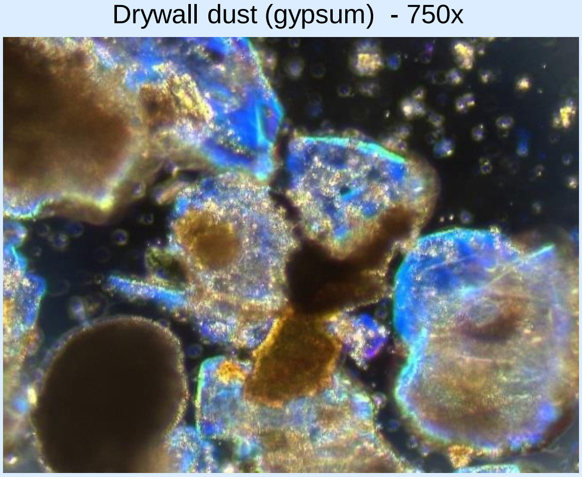
Construction materials are composed mostly of carbonate, gypsum, and silicate particles generated from the application and renovation of building components, drywall, patching compounds, flooring adhesives, and paint. Infiltrated soil minerals are mostly composed of naturally occurring aluminum silicate clays, quartz, and Calcium carbonates and sulfates. Mineral dust particles can include optically opaque to transparent birefringent and non-birefringent particles.



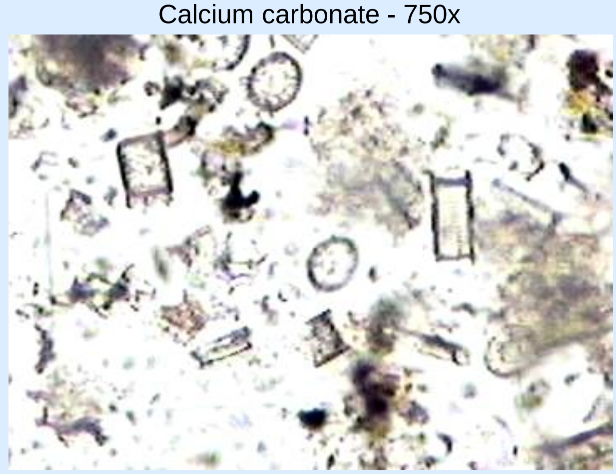
Drywall dust (gypsum) - 750x



Calcium carbonate - 750x



Quartz beach sand - dispersion staining - 100x



Diatomite - 750x

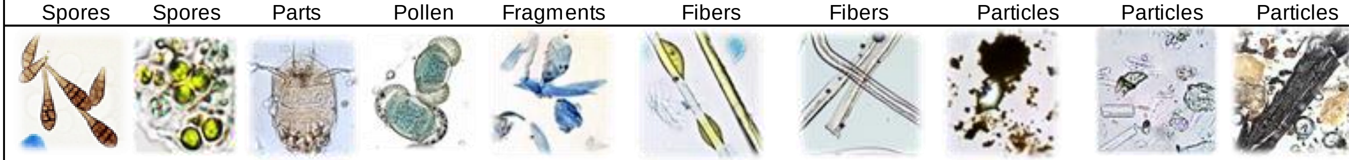
GENERAL AIRBORNE MOLD AND DUST PARTICLE GUIDELINES

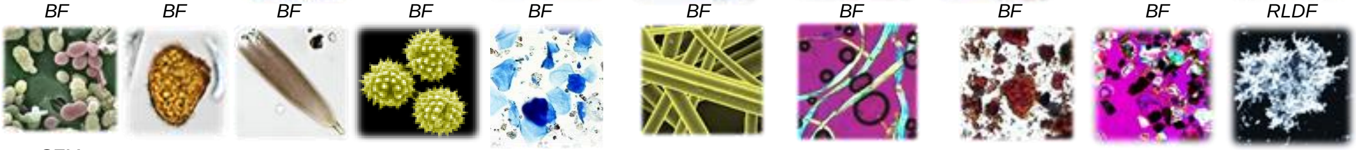
AIR PROFILE™ LABORATORY PARTICLE CLASSIFICATION AND POSSIBLE ACTION LEVELS

The classifications for common indoor particles analyzed in the ***AIR PROFILE***™ report are based on a combination of their origin, morphology, optical properties, and potential building condition they may represent (see the *Airborne and Surface Dust Interpretation Guide* located on our website at eaalab.com). Example micrographs of particles representative of each classification and the Optical and Electron Microscopy imaging techniques used are shown below:

PARTICLE CLASSIFICATIONS

Mold Spores | Algal / Fern Spores | Insect Parts | Pollen | Skin Cell Fragments | Fiberglass Fibers | Cellulose / Synthetic Fibers | Optically Opaque Particles | Crystalline Mineral Particles | Fire Residue Particles





BF = Bright Field Optical Microscopy, RLDF = Reflected Light Dark Field Optical Micrososcopy,

PLM = Polarized Light Microscopy, SEM = Scanning Electron Microscopy

The following ***AIR PROFILE***™ classifications, exposure ranges, and possible response actions are to be used in conjunction with the visual inspection observations:

Classification	Level	Percentile	Condition / Potential Response Actions
Elevated	6	>99th	Significantly elevated - Further investigation warranted
Elevated	5	95th- 99th	Elevated - Further investigation likely warranted
Atypical	4	90th- 95th	Atypical - Further investigation may be warranted (If levels found in multiple samples)
Atypical	3	75th- 90th	Atypical - Further investigation may be warranted (If levels found in multiple samples)
Typical	2	50th- 75th	Typical background / acceptable - No action indicated
Typical	1	<50th	Below the average or typical background - No action indicated

The ***AIR PROFILE***™ measured airborne concentration ranges associated with each classification are summarized below:

INDOOR AIRBORNE CLASSIFICATION GUIDELINES

Approximate Percentile Concentration Thresholds (Cts/m^3) - Based on the EAA nationwide database

Classification	Percentile	Total Mold	Chronic Asp / Pen	* W.I. Mold	Outdoor Mold	Algal Fern	Insect Parts	Pollen	Skin Cell Frag.	Fiber-glass	Cellulose **/ Syn Fibers	Opaque Dust	Mineral Dust		*** Fire Residue
Elevated - 6	>99th	>40000	>22000	>240	>16000	>950	>1000	>40	>30000	>650	>5900	>41000	>132000		No data
Elevated - 5	>95th	>12000	>3500	>100	>8000	>500	>500	>13	>15000	>90	>1800	>13000	>41000	10x bkg.→	>1000
Atypical - 4	>90th	>6000	>1000	>50	>5000	>240	>180	>7	>10000	>30	>1100	>7800	>22000		
Atypical - 3	>75th	>1600	>140	>20	>1500	>140	>60	>7	>6000	>8	>600	>3700	>9000	3x bkg.→	>300
Typical - 2	>50th	>400	>18	>11	>360	>90	>60	>3	>3050	>4	>290	>1800	>4400		>100
Typical - 1	<50th	<400	<18	<11	<360	<90	<60	<3	<3050	<4	<290	<1800	<4400	bkg. → (2x d.l.)	<100

Note: The calculated data shown on page 9 has been rounded "up" to 3 decimal places to define each exposure classification range

* *W.I. = Water indicating, ** Syn = Synthetic*

*** *Preliminary fire particle data is in a separate database of non fire complaint related buildings. Because of the high percentage of measurements found below the limit of detection (~40%), the comparison guidelines are based on the differential above a value of twice the method detection limit (d.l.). Atypical and Elevated classifications are defined as 3 and 10 times the background (bkg) respectively.*

d.l. = 50cts/m^3

GENERAL SURFACE MOLD AND DUST PARTICLE GUIDELINES

SUGGESTED LABORATORY CLASSIFICATION RANKING AND ACTION LEVELS

CAUTION ON THE USE OF THE ***DUST PROFILE*** CLASSIFICATIONS

Laboratory results are secondary information used to support a thorough visual inspection performed by a qualified environmental professional. The EAA concentration ranges, descriptions (i.e. Typical, Atypical, or Elevated), and color-coding system are designed to provide additional clarity when making comparisons with concentration ranges found in other buildings. Singular analytical results, the descriptions, and/or the color-coded ranges cannot be used as the primary criteria to determine if a "safe", "unsafe" or "elevated" condition exists in any specific building.

Multiple (not singular) sample measurements should be used to support the visual inspection observations.

The DUST ***PROFILE*** ™ classifications and suggested response actions for each exposure range are given below.

Classification	Level	Percentile	Condition / Potential Response Actions
Elevated	6	$>99^{th}$	Further investigation warranted
Elevated	5	95^{th}- 99^{th}	Further investigation likely warranted
Atypical	4	90^{th}- 95^{th}	Atypical - Further investigation suggested
Atypical	3	75^{th}- 90^{th}	Atypical - Further investigation (If levels found in multiple samples)
Typical	2	50^{th}- 75^{th}	Typical background / acceptable - No action indicated
Typical	1	$<50^{th}$	Acceptable / typical background - No action indicated

The ***DUST PROFILE*** ™ measured surface concentration ranges associated with each classification are summarized below.

INDOOR SURFACE DUST CLASSIFICATION GUIDELINES

Approximate Percentile Concentration Thresholds (Cts/mm^2) For "Typical" Buildings - Based on the EAA nationwide database

Classification	Percentile	Total Mold	Asp / Pen	* Water Indicating Mold	Outdoor Mold	HYP	Algal Fern	Insect Parts	Pollen	Skin Cell Frag.	Fiber-glass	Cellulose Synthetic Fibers	Opaque Dust	Mineral Dust	** Fire Residue Non-supect
Elevated - 6	$>99^{th}$	>40	>6	>0.1	>30	>3		>16	>10	>260	>3	>75	>700	>900	*** I.D.
Elevated - 5	$>95^{th}$	>10	>1	>0.01	>7	>1		>8	>2	>150	>1	>50	>130	>240	>50
Atypical - 4	$>90^{th}$	>5	>0.1	>0.01	>4	>0.7		>4.0	1.0	>110	>0.7	>25	>60	>140	>10
Atypical - 3	$>75^{th}$	>2.0	>0.05	>0.010	>1	>0.1		>1.0	>0.3	>35	>0.1	>10	>20	>60	>5
Typical - 2	$>50^{th}$	>0.2	>0.01	>0.001	>0.1	>0.02		>0.7	>0.04	>12	>0.03	>3	>7	>15	>1
Typical - 1	$<50^{th}$	<0.2	<0.01	< 0.001	<0.1	<0.02		<0.7	<0.04	<12	<0.03	<3	<7	<15	<1
Frequency of detection		63%	9%	0.7%	63%	20%	0%	2%	33%	96%	26%	93%	98%	99%	32%

Note: The values have been rounded "up" to 3 decimal places to define each exposure classification range

*** Fire residue samples collected from non suspect fire-related complaint buildings. Estimates only*

**** I.D. = Insufficient data*

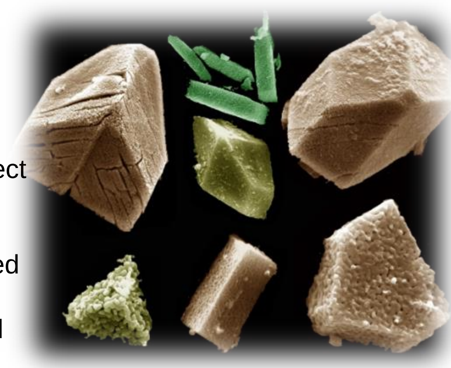
AUTOMATED SEM / X-RAY DUST ANALYSIS PROCEDURES

Specialized testing offered by Environmental Analysis Associates

In late 2021, Environmental Analysis Associates, Inc. consolidated the San Diego, California laboratory into the Bay City, Michigan facility. The Michigan facility now has two Scanning Electron Microscopes equipped with specialized automated X-ray particle analysis software specifically designed to identify and quantify indoor air quality contaminants often associated with the causation of dust-related indoor air quality complaints.

The data collected by the SEM and EDAX™ Particle™” X-ray software is converted into a statistical report format developed by EAA. The analysis reports provide particle size distribution and elemental chemistry analysis designed for use by environmental health professionals. The reports provide direct estimates of quantitative sample chemistry, mass and size distribution, including mass estimates of respirable and inhalable sized dust (e.g. $PM_{2.5}$ and PM_{10}).

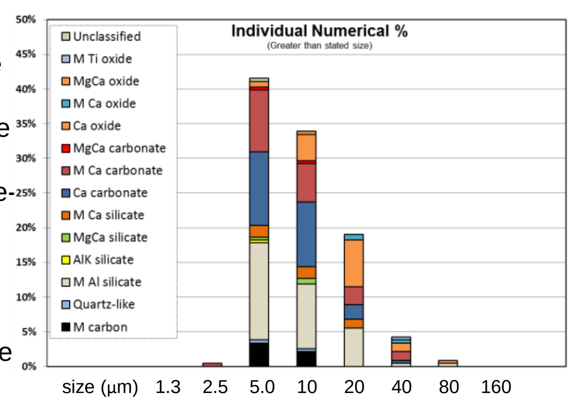
SAMPLE COLLECTION METHODS

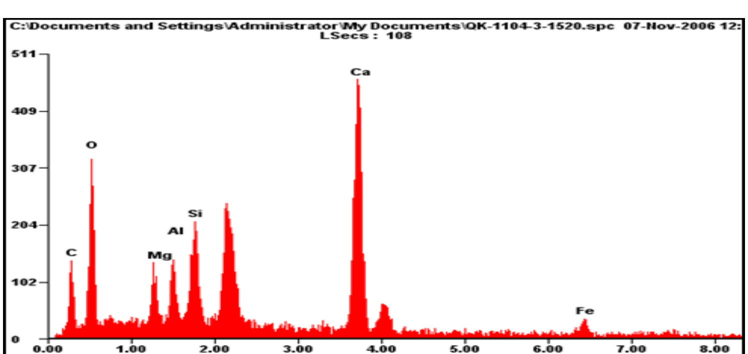


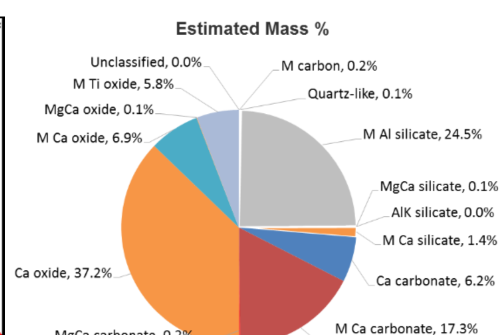
Different types of sample collection media can be used depending on the type of sample being analyzed. Bulk, vacuum, or adhesive tape lift media can be used to collect surface dust samples. The direct preparation of adhesive tape media is the preferred procedure to evaluate settled dust samples. Water samples can be filtered using 0.4µm polycarbonate filter media. Airborne samples can be collected using polycarbonate filters or Zefon™ Air-O-Cell CSI™ slit impaction samplers that contain adhesive media compatible with the SEM and Dispersive X-ray analysis.

ANALYSIS METHOD SUMMARY

The SEM analysis method is utilized as a semi-quantitative diagnostic testing procedure to estimate the size and Elemental distribution of individual particles within a surface dust, airborne dust, or water sample. The method is well-suited to simultaneously provide gravimetric mass measurements when chemistry information cannot be collected by using conventional methods. Optical Microscopy methods are recommended for the analysis of biological fibers and particles (mold, pollen, etc.) and not SEM analysis. A flow diagram for the suggested use this method is given on page 4 of this document.







AUTOMATED SEM/X-RAY DUST ANALYSIS PROCEDURES

Table of the most common sources and classification of indoor inorganic dust particles

The following are the most common examples of how materials are classified in the automated SEM report:

Material Description	Naturally Occurring?	Building Source/Composition	Common X-ray Classifications
Common Building Components			
Carbonaceous	Y - common	Biological synthetic particles fibers	M carbon **
Asphaltic	N	Roofing / patching	S carbon
Quartz	Y - common	Concrete, sand, plasters	Quartz-like, Si oxide
Mixed silicate clays	Y - common	Soil infiltration, plasters, insulation	M Al silicate **
Vermiculite	N	Spray on insulation (variable)	M Al silicate (special)**
Calcium sulfate	Y - rare	Drywall board / compounds	Ca sulfate
Calcium carbonate	Y - low	Concrete, patching compounds	Ca carbonate
Calcium silicate	Y - low	Concrete, patching compound, plasters	Ca silicate
Magnesium silicate	N	Concrete, patching compound, plasters	Mg silicate
Calcium / Magnesium silicate	N	Concrete, patching compound, plasters	MgCa silicate
Titanium Paints	N	Coatings - Wall, ceiling tiles, etc	M Ti oxide **
Corrosion Particles			
Iron oxide	Y - moderate	Pipes, motors, HVAC components	Fe oxide
Al oxide	Y - moderate	HVAC, ducting, brackets, windows	Al oxide
Zn oxide	N	Galvanized HVAC coatings	Zn oxide
AlZn oxide	N	HVAC ducting / components	AlZn oxide
Mixed Aluminum/ Iron oxide	N	HVAC components / drip pans	AlFe oxide
Mixed Aluminum/ Iron/Copper oxide	N	Mixed HVAC components	AlFeCu oxide
Mixed Iron/Chromium Oxide	N	Steel corrosion particles	CrFe oxide
Cu oxide	N	Copper piping	Cu oxide
Combustion Residue Particles			
Soot / char particles	Y	Heated carbonaceous components	H carbon
Vegetation ash	Y	Residual mineral salts–combustion	Ca,Mg,K oxides
Plant phytoliths	Y	Outdoor infiltration – vegetation	Ca, Si oxides

It is important to note that most materials are not “pure” and minor amounts (1-5%) of other common elements are usually found in association with each classification.

* The particle minor element chemistry and morphology occasionally needs to be considered to classify the particles appropriately

** An “M” prefix refers to “mixed” element classification (e.g. M carbon for mixed carbon)

SEM / X-RAY PARTICLE CLASSIFICATION SYSTEM

BASIC PARTICLE "CLASSIFICATION" RULES FOR COMMON DUST SAMPLES

CLASSIFICATION	DESCRIPTION	* Approximate Wt. %/Size (ZAF) "Guidelines" *Note: Values must be adjusted for particles <3um*	
CARBONACEOUS	Biogenic and organic	Primary	Secondary
H carbon	High carbon (only minor amounts of other elements)	C >80%	All other <3% (except O)
M carbon	Moderate/mixed carbon (only minor amounts of other elements)	C >50%	All other <10% (except O)
N carbon	Carbon (minor amount Nitrogen >5%)	C >50%	N > 5%
"Cl,Si,Ba,S," carbon	Moderate carbon with 2 or less element combinations	C >50%	Other >5%
SILICATES	Construction materials / soil minerals		
Quartz-like	Quartz / Quartz-like - Predominant Si & O / low carbon	Si >20%, O>20%	Other <5%
M Al silicate	Aluminum Silicates - Predominant Al Si	Al >3%, Si >10%	Other <5%
Fe Al silicate	Aluminum silicate - Significant Iron present	Al>3%, Si>10%	Fe >5%
Ca silicate	Calcium silicate - Ca / Si wi. absence of signficant carbon	Al>3%, Si>10%	Ca >5%
K Al silicate	Possible feldspar minerals (Orthoclase) / other	Al>3%, Si>10%	K >5%
Ca Al silicate	Possible feldspar minerals (Plagioclase) / other	Al>3%, Si>10%	Ca >5%
M silicate	Mixed silicate with 3 or more cation elements other than Si	Si >10%, O>20%	Cations >5%
CARBONATE	Construction materials / soil minerals		
Ca Carbonate	Calcium Carbonate	Ca>15%,	C<50%
MgCa Carbonate	Magnesium Calcium Carbonate (2 predominant)	Ca / Mg >10%	C<50%
Ca oxide	Calcium oxide / oxalate	Ca>30%	C<20%, O >25%
M carbonate	Carbonate - Mixed with 3 or more elements none predominant	All cations 3-5%	C>30%, O>20%
SULFATE	Construction materials / precipitated salts		
Ca sulfate	Calcium sulfate (drywall dust)	Ca>10%, S>5%	Other <3%
Na sulfate	Sodium sulfate - efflouresence salts	Na>10%, S>5%	Other <3%
MgCa sulfate	Magnesium/Calcium sulfate (2 predominant)	Mg/Ca>10%, S>10%	Other <3%
Ba sulfate	Barium sulfate	Ba>10%,S>10%	Other <3%
Zn sulfate	Zinc sulfate (Zinc, Sulfur and Oxygen)	Zn>10%,S>10%	Other <3%
M sulfate	Sulfate - Mixed with 3 or more elements none predominant	S>10%	Other cations >5%
SULFIDE	Reducing enviroment particles (Low oxygen)		
C sulfide	Carbon sulfide (very low oxygen)	C>50%, S>10%	Other <3%
Na sulfide	Sodium sulfide	Na>10%, S>10%	O <20%, Other <3%
Zn sulfide	Zinc sulfide	Zn>10%, S>10%	O <20%
M sulfide	Sulfide - Mixed with 3 or more elements not predominant	Cation>10%, S>5%	Other cations <5%
CHLORIDE	Evaporated salts or water induced metal corrosion		
Na chloride	Sodium chloride	Na>10%, Cl>10%	C & O <20%
NaMg chloride	Sodium / magnesium salts (2 predominant)	Na/Mg >10%	C & O <20%
M chloride	Chloride - Mixed with 3 or more elements none predominant	Cation>10%, Cl>5%	C & O <20%
OXIDE	Corrosion particles / possible fire "ash" (see next page)		
Quartz (Si oxide)	See silicate category		
Ca oxide	Calcium oxide - Construction materials / oxalate fire ash	Ca>30%, O>20%	C < 20%
Na oxide	Likely evaporated sodium hydroxide	Na>30%, O>20%	C < 20%
Al oxide	Aluminum oxide - pos. corrosion / mineral	Al>30%, O>20%	C < 30%
Fe oxide	Iron oxide - pos. corrosion / mineral	Fe>15%, O>20%	C < 50%
Zn oxide	Zinc oxide - Corrosion	Zn>15%, O>20%	C < 50%
AlZn oxide	Aluminum and Zinc oxide - Pos. corrosion	Al / Zn >15%	C < 50%
Cu oxide	Copper oxide	Cu>15%, O>20%	C < 50%
M Al,Fe,Zn, oxide	3 specific metals present	All >5%	C < 50%
M oxide	Oxide - Mixed with 3 or more elements none predominant	3 or more cations >5%	
UNCLASSIFIED / MIXED ELEMENTS			
Unclassified	Composition not identifiable		
M composition	Mixed composition 5 + elements/mixed agglomerate composition (i.e. mixed carbonate/sulfate/silicate)		

**** Wt% guidelines can vary based on particle geometry and background of the carbon substrate.***

Note: This classification system is designed as a systematic way to generally categorize (classify), and define the gross composition of an individual particle. The "classification" is first assigned based on the visual rank order elemental predominance in the X-ray spectrum. A chi-square classification fit of 65-75% is used. The name given to the "classified" particle is based on the most likely mineralogy found in the natural or indoor environment. The "classification" combinations may not always correctly define the exact composition of a particle, or always correctly represent the rank order quantitative elemental chemistry. Multiple sets of elemental ratio rules are used for "small" verses "large" particles due to increased beam penetration in particles smaller than 5um into the Carbon/Oxygen adhesive substrate. This limitation affects the measured apparent elemental stoichiometry. A 2nd manual review of particle spectra is conducted to verify particle ID.

AUTOMATED SEM ANALYSIS REPORT

Example Data Summary Page

ENVIRONMENTAL ANALYSIS ASSOCIATES, Inc. - 5290 Soledad Road - San Diego, CA 92109 - (858) 272-7747

Automated Scanning Electron Microscopy Dust Analysis - Summary Report

Surface/Bulk Dust Analysis - Quantitative

Client Name :	ABC Environmental	Analysis Method :	*SEM-D01*
Contact :	Mr. John Doe	Sample collected :	*11/1/18*
Client Project# :	ABC18-1000	Sample received :	*11/1/18*
Client Sample # :	B-2	EAA Project # :	18-3131
Sample Description :	Montecito Fire Ash - background sample	EAA Sample # :	3131-2
Sample media / type code :	Surface/Bulk dust analysis	Fields / passes counted :	3
Analysis Magnification :	147	Field area counted (mm^2) :	1.549
Scale (µm/div.) :	1		
Total particles counted :	211	Particles / mm^2 :	136
		Particles/sampled area :	210
Min./Max. size range (µm) :	5.0 / 2000	Est. particle thickness ratio (S:l) :	1

SUMMARY CONCLUSIONS

The Montecito fire ash sample contains a distribution consistent with moderate concentrations of Magnesium, Potassium, and Calcium oxides and carbonates (~26% by mass). The high concentrations of large clay particles (M Al silicate, MgAl silicate) are also an indication of high concentrations of soil mineral particles. High concentrations of ash fragments and plant phytoliths are also visible in the backscatter electron images given in photo report on page 2.

Numerical & Mass % Concentration Summary — *Mass within analyzed area only*

Particle Classification	# Cted	Mean (µm)	Num. %	*Calc Mass %	*Spec Grav	* Part. / sampled area	Part. / mm^2	*Theoretical ug / mm2	Calc.Mass ug / cm2
M carbon	46	11.2	21.8%	11.8%	1.50	46	30	1.0	103.6
Quartz-like	5	17.5	2.4%	0.4%	2.00	5	3	0.0	3.1
M Al silicate	72	20.0	34.1%	35.6%	2.00	72	46	3.1	312.2
AlK silicate	15	16.0	7.1%	1.0%	2.00	15	10	0.1	8.9
MgAl silicate	22	31.5	10.4%	21.7%	2.00	22	14	1.9	189.9
KCa silicate	1	22.8	0.5%	0.1%	2.00	1	1	0.0	0.8
Ca silicate	1	13.4	0.5%	0.0%	2.00	1	1	0.0	0.2
Ca oxide	11	24.6	5.2%	10.5%	2.00	11	7	0.9	92.3
MgKCa oxide	10	30.6	4.7%	15.9%	2.00	10	6	1.4	138.9
KCa oxide	3	9.3	1.4%	0.0%	2.00	3	2	0.0	0.2
MgCa oxide	8	17.1	3.8%	0.4%	2.00	8	5	0.0	3.9
M Ca carbonate	9	19.0	4.3%	2.4%	2.00	9	6	0.2	20.9
Cu metal	1	16.8	0.5%	0.04%	2.00	1	1	0.0	0.3
Fe oxide	3	10.6	1.4%	0.04%	2.00	3	2	0.0	0.4
Unclassified	2	11.3	0.9%	0.1%	2.00	2	1	0.0	0.5
TOTALS	209					210	136		880.0

** The theoretical calculated mass is based on the sum total of each particle volume & theoretical specific gravity. Calculations assume an estimated thickness ratio and should be used as rough comparative mass estimates only.*
All "classifications" are presumptive and represent the most likely common mineral or chemical present.
All calculated values are rounded to 3 significant figures, and should be considered accurate to 2 significant figures.

Authorized / data reviewed by : *Daniel M. Baxter* Date : *11/16/18*

Analyst : *DMB* Date analyzed : *11/15/18*

Sample results are only applicable to the items or locations tested.
Sample descriptions and volumetric data are provided by the client.

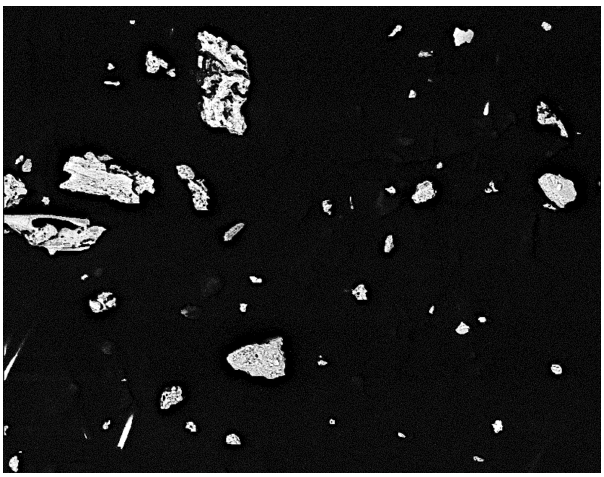
AUTOMATED SEM ANALYSIS REPORT

Example Photo Page

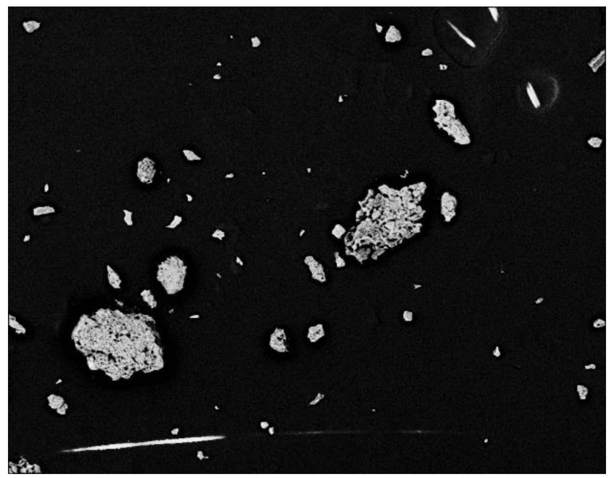
ENVIRONMENTAL ANALYSIS ASSOCIATES, Inc. - 5290 Soledad Road - San Diego, CA 92109 - (858) 272-7747

Automated Scanning Electron Microscopy - Dust Analysis Photo Report

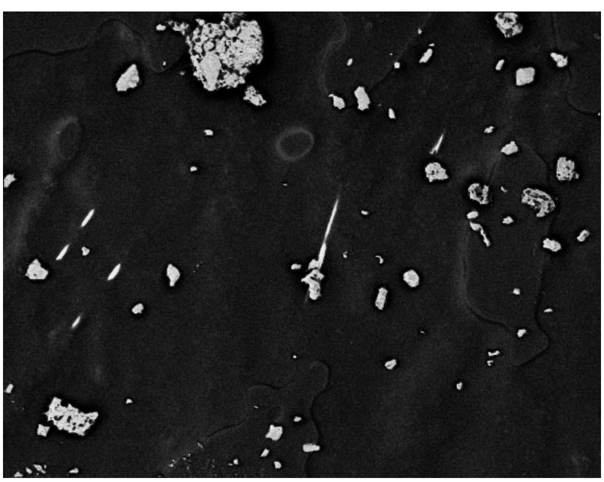
Client Name :	ABC Environmental	Sample received :	11/1/18
Contact :	Mr. John Doe	EAA Project # :	18-3131
Client Project# :	ABC18-1000	EAA Sample # :	3131-2
Client Sample # :	B-2		
Sample Description :	Montecito Fire Ash - background sample	Backscatter electron image	
Analysis Method :	Surface/Bulk dust analysis	Sample Magnification	147



Field 1



Field 2



Field 3

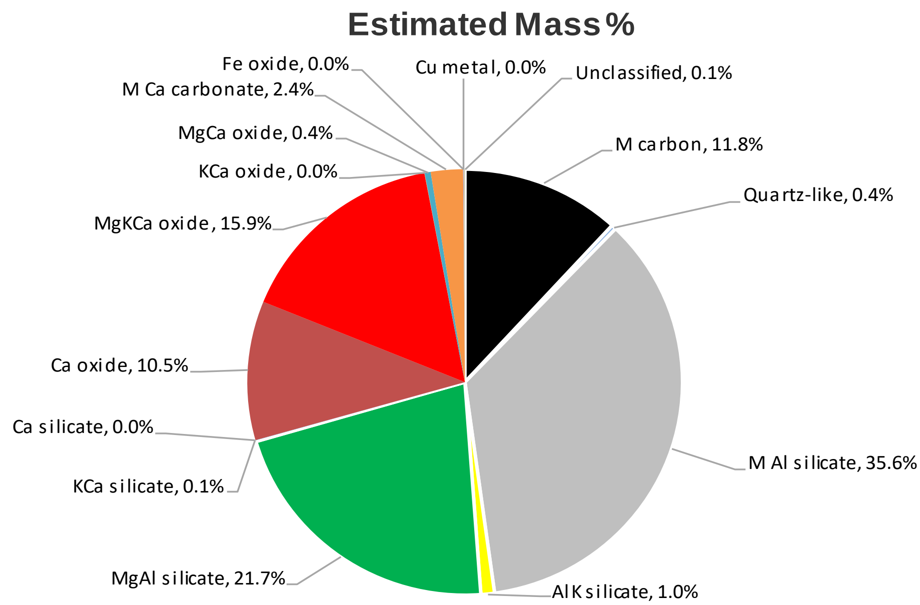
AUTOMATED SEM ANALYSIS REPORT

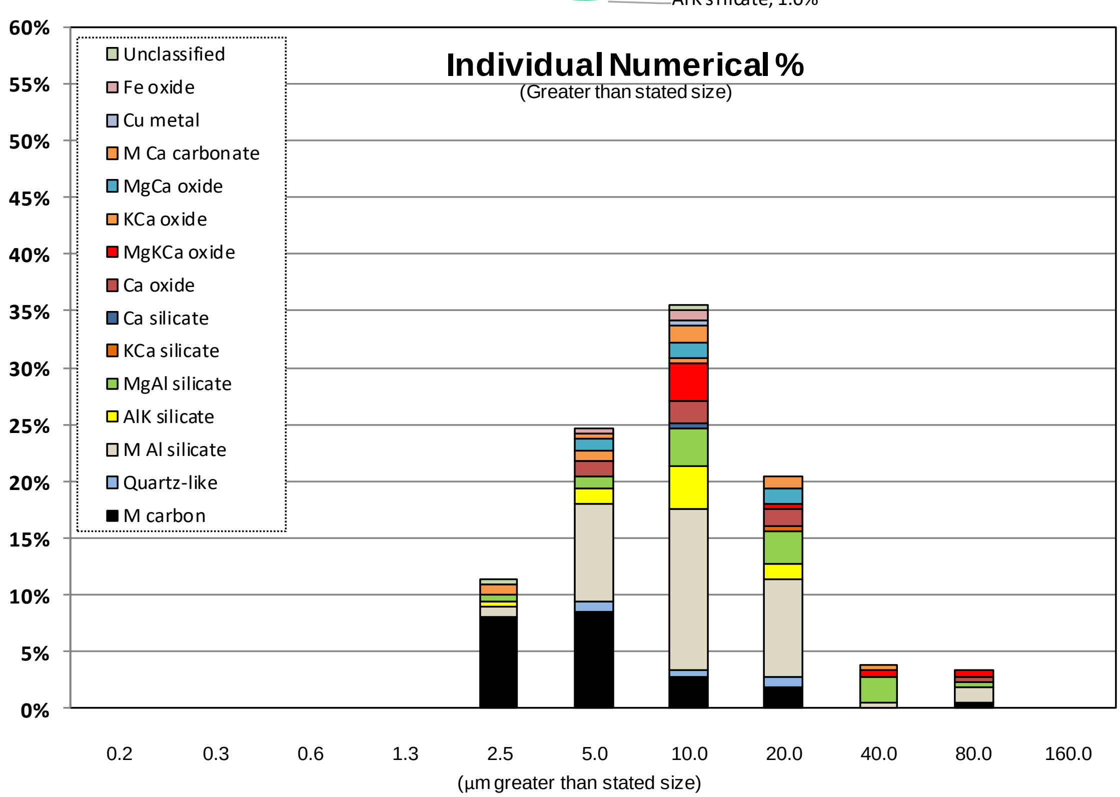
Graphical report

ENVIRONMENTAL ANALYSIS ASSOCIATES, Inc. - 5290 Soledad Road - San Diego, CA 92109 - (858) 272-7747

Automated Scanning Electron Microscopy -Grapical Report - Mass & Size Distribution

Client Name :	ABC Environmental	Sample received :	11/1/18
Contact :	Mr. John Doe	EAA Project # :	18-3131
Client Project# :	ABC18-1000	EAA Sample # :	3131-2
Client Sample # :	B-2	EAA Method # :	SEM-D01
Sample Description :	Montecito Fire Ash - background sample		
Analysis Method :	Surface/Bulk dust analysis		





AUTOMATED SEM ANALYSIS REPORT
Example Graphical X-ray Data Page

ENVIRONMENTAL ANALYSIS ASSOCIATES, Inc. - 5290 Soledad Road - San Diego, CA 92109 - (858) 272-7747

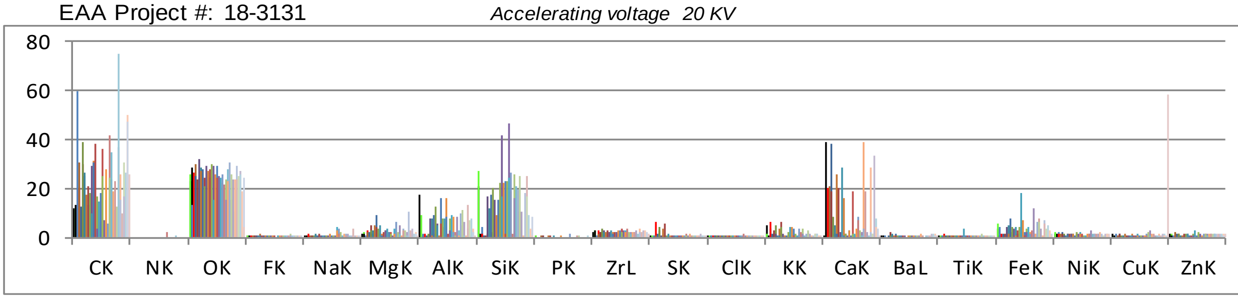
PARTICLE CHEMISTRY - GRAPHICAL REPORT

(Elemental Composition - Weight %)

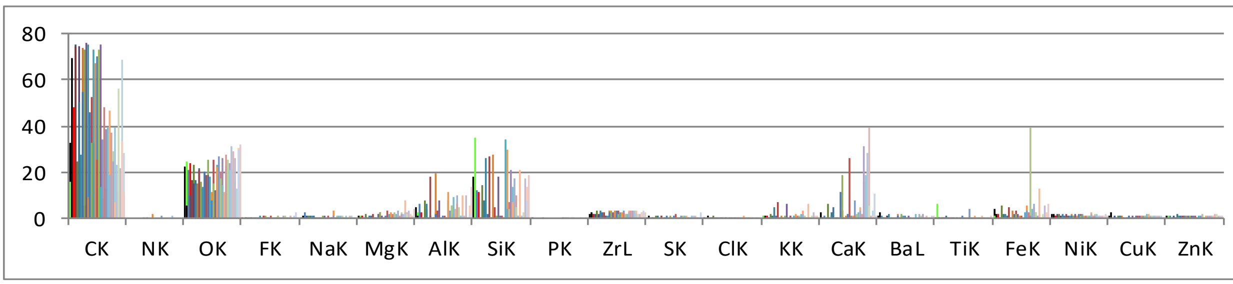
Cambridge S-240 SEM equipped with EDAX Octane SDD detector

Client Name: ABC Environmental Client Sample # : B-2

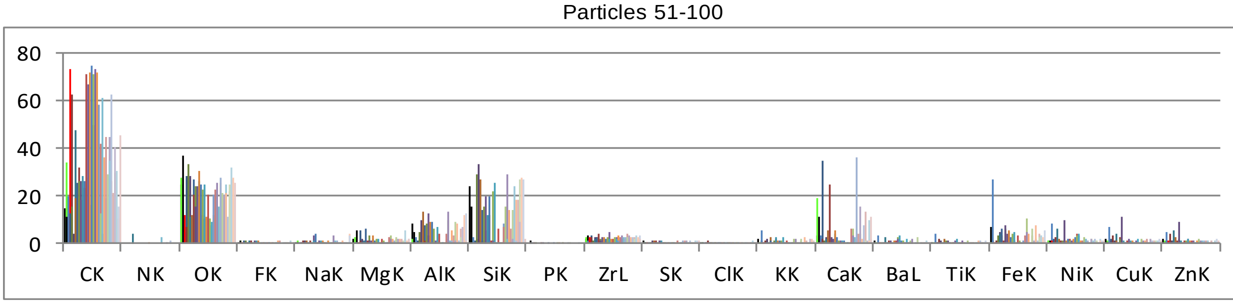
EAA Project #: 18-3131 *Accelerating voltage 20 KV*



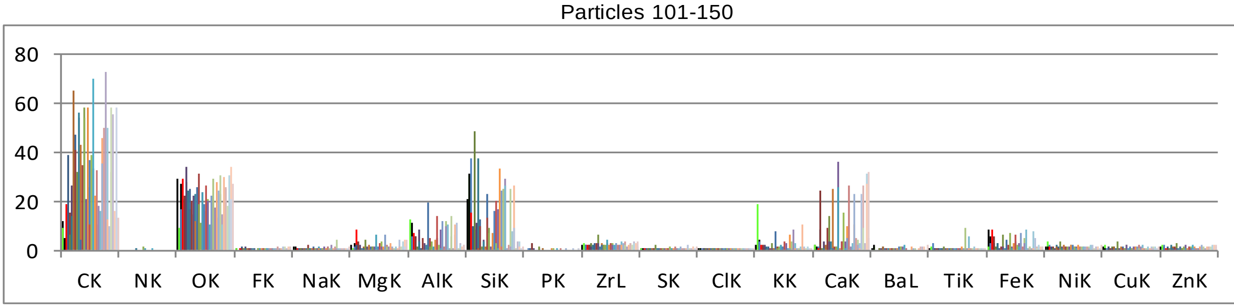
Particles 1-50



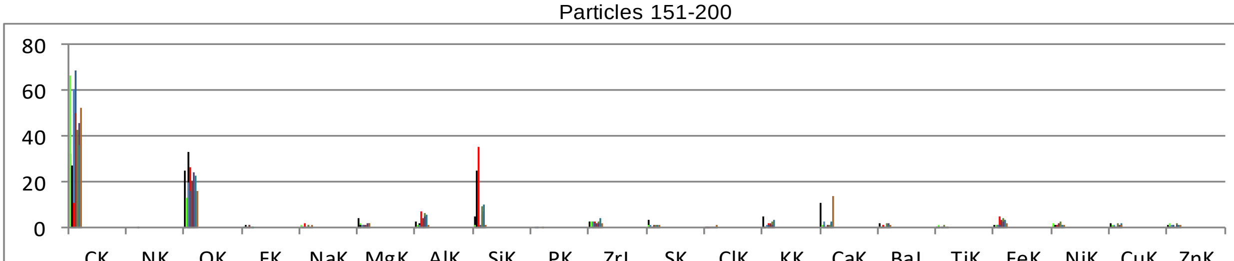
Particles 51-100



Particles 101-150

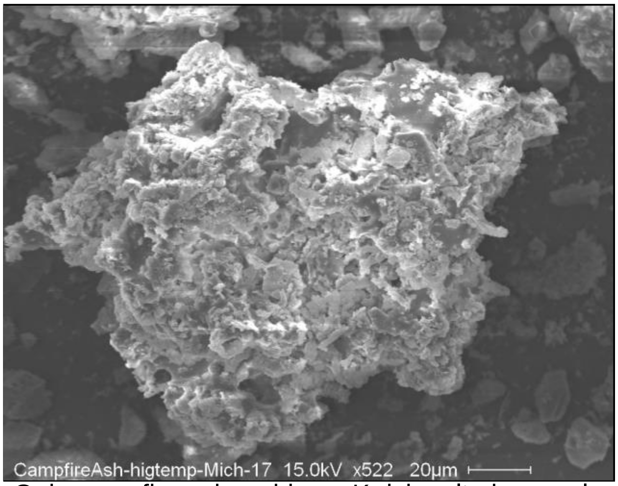


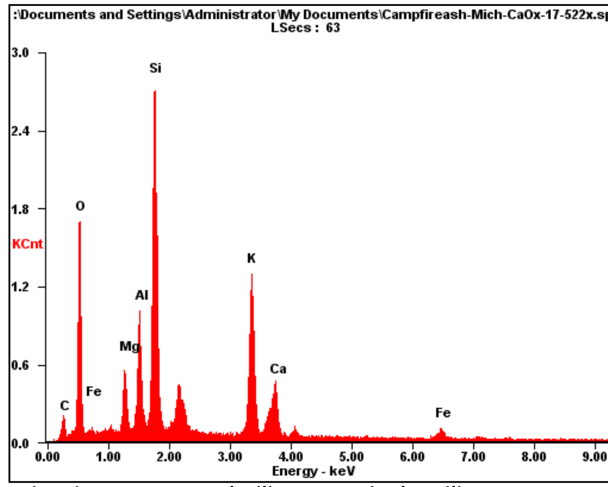
Particles 151-200



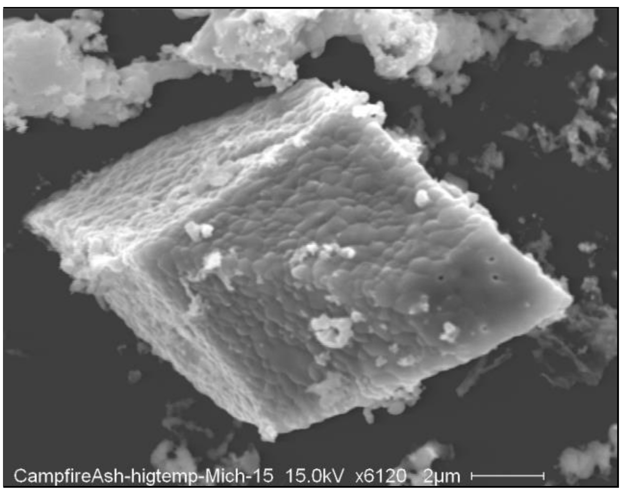
Particles 201-250

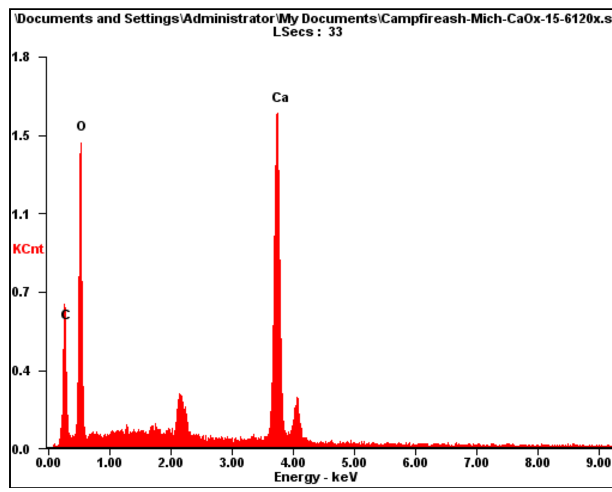
Note: X-axis is the element category followed by the electron shell used for quantification (e.g. "Na" [element], "K" [k electron shell])



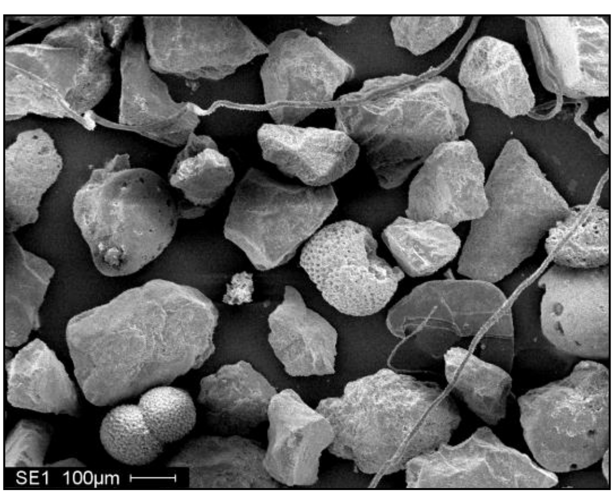


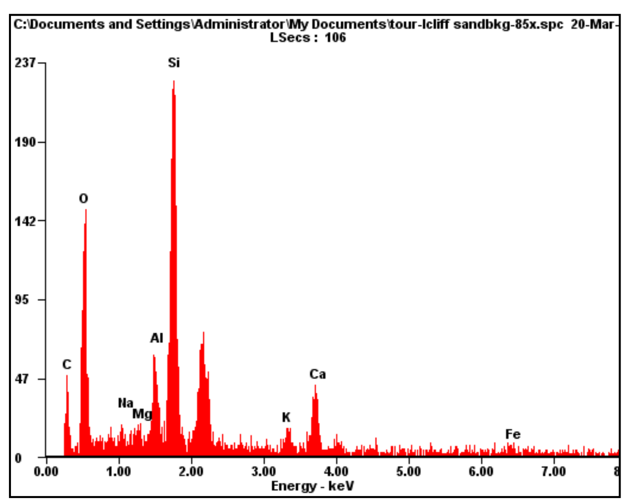
Oak camp fire ash residue – K rich salt given a classification between M Al silicate and AlK silicate





Oak camp fire ash – Calcium oxalate phytolith (Ca oxide / oxalate)

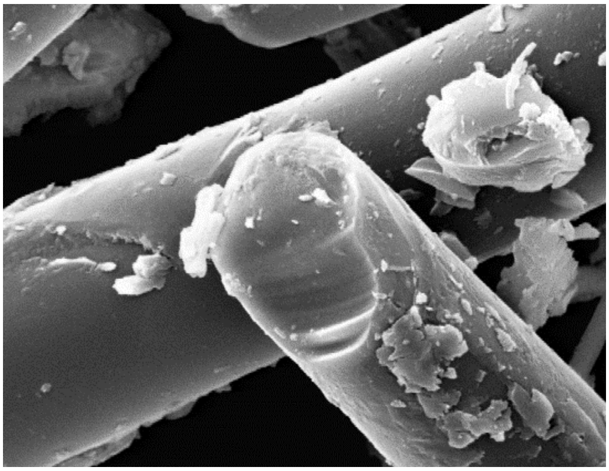


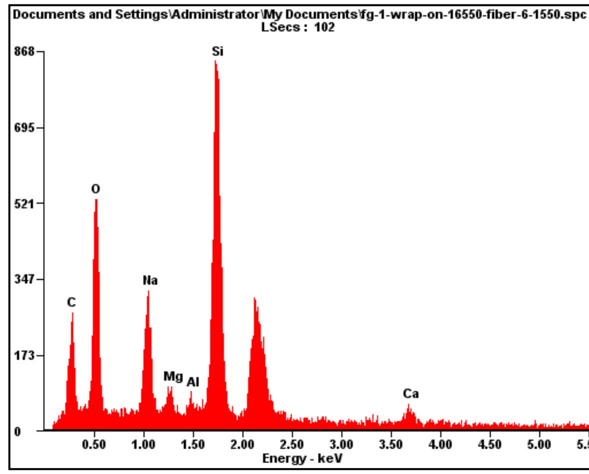


Fossiliferous beach sand Tourmaline Beach, San Diego - >125um sieved size fraction

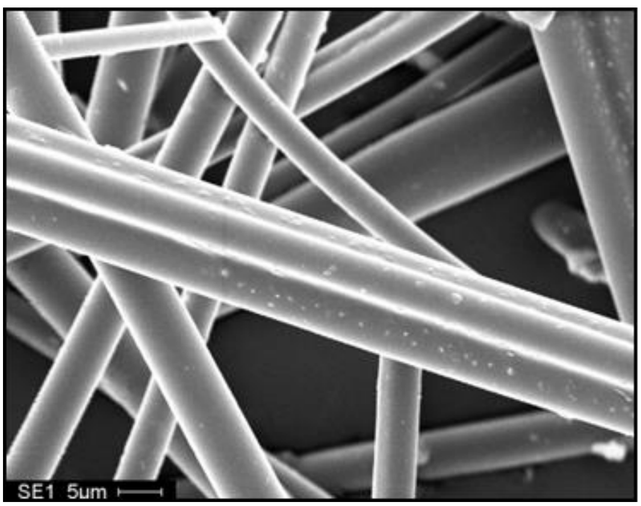
COMMON EXAMPLE PARTICLES

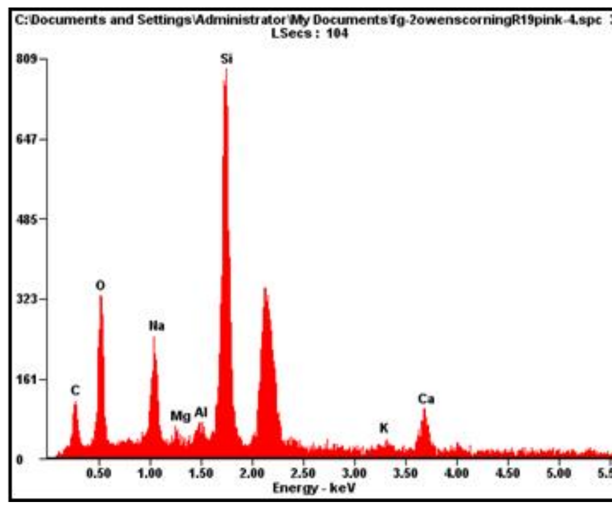
Example particles images & X-ray spectra – Fiberglass insulation fibers



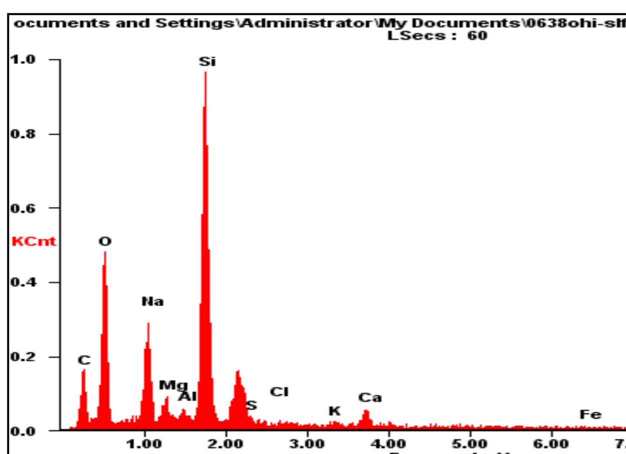


Wrap-on Fiberglass insulation #16550. High Na, low Ca glass





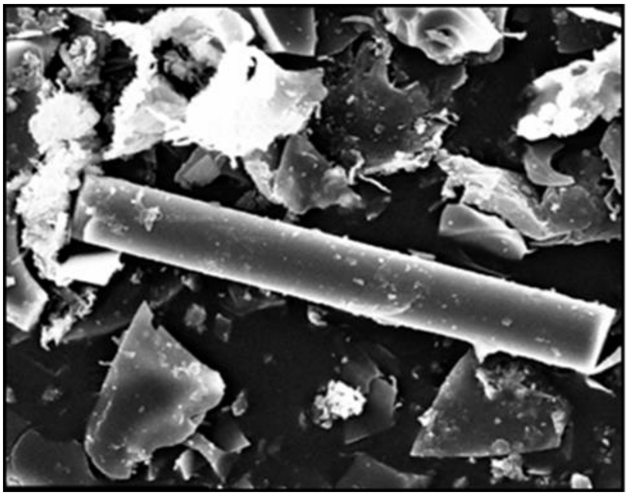
Owens Corning Pink insulation R-19 . High Na, moderate Ca glass

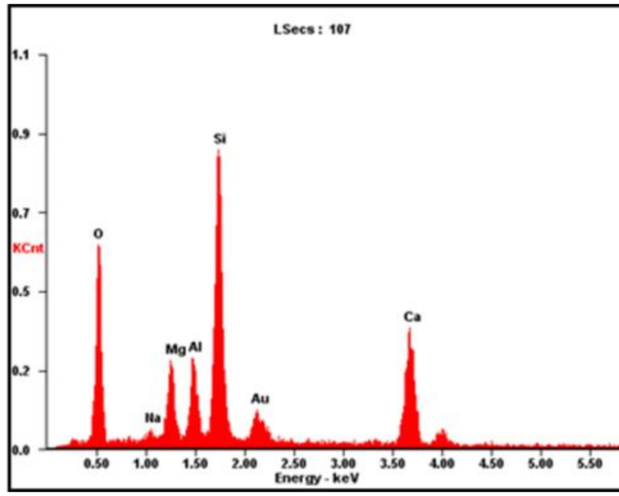


Sound liner fiberglass from HVAC system mixing box (optical microscopy)- 600x

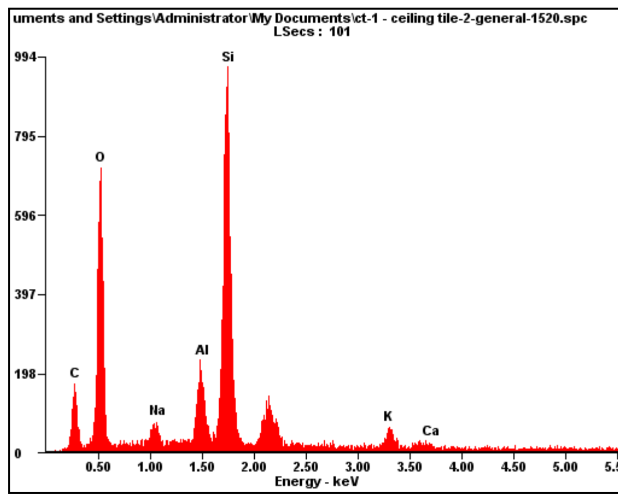
COMMON EXAMPLE PARTICLES

Example particles images & X-ray spectra – Drop ceiling tile dust

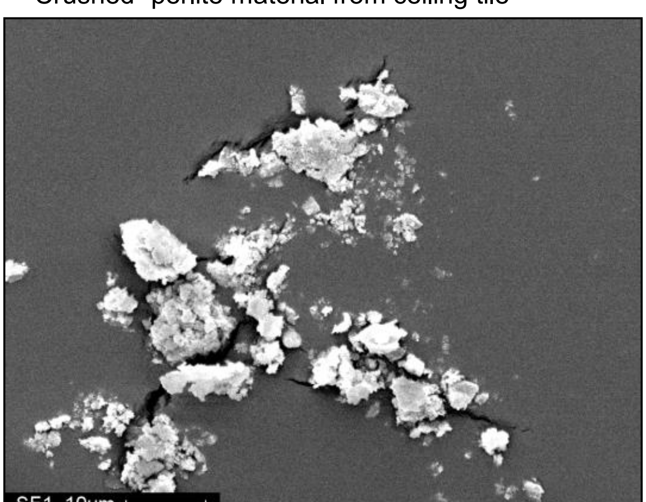


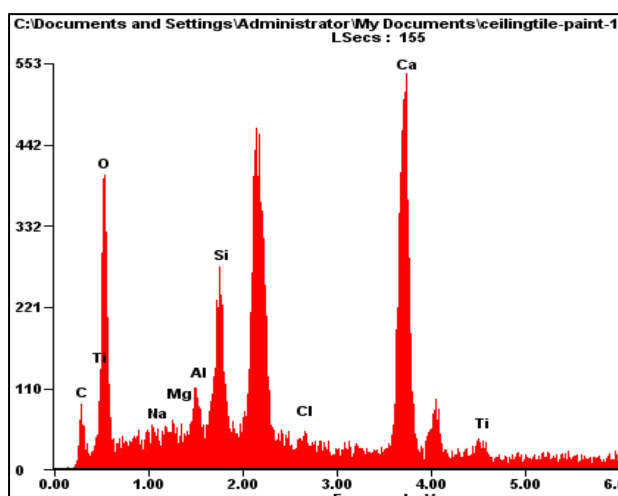


Fiberglass fibers in ceiling tiles. High Ca, low Na



“Crushed” perlite material from ceiling tile

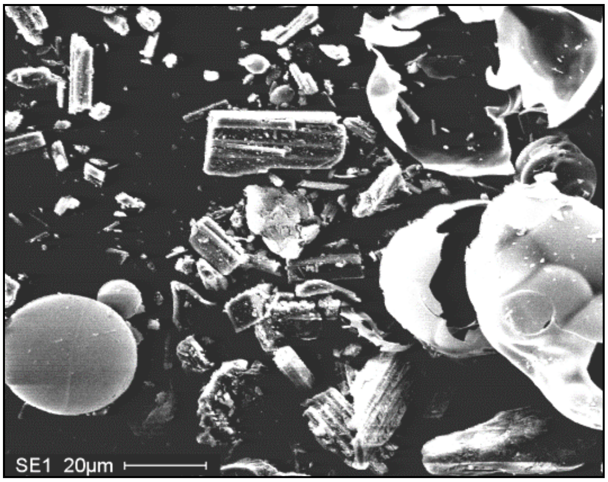


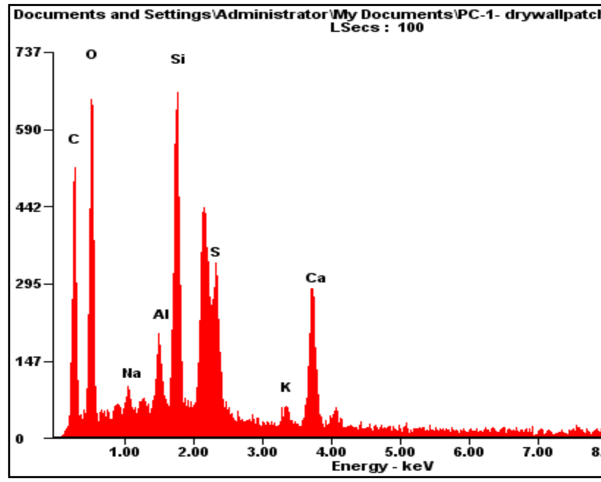


Paint from ceiling tile surface

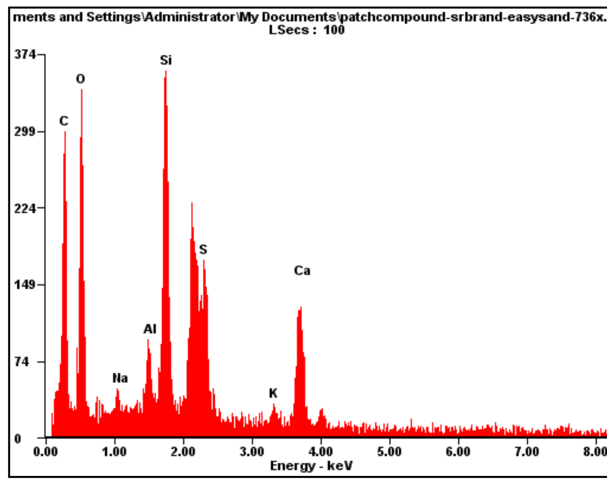
COMMON EXAMPLE PARTICLES

Example particles images & X-ray spectra – Drywall patching compounds

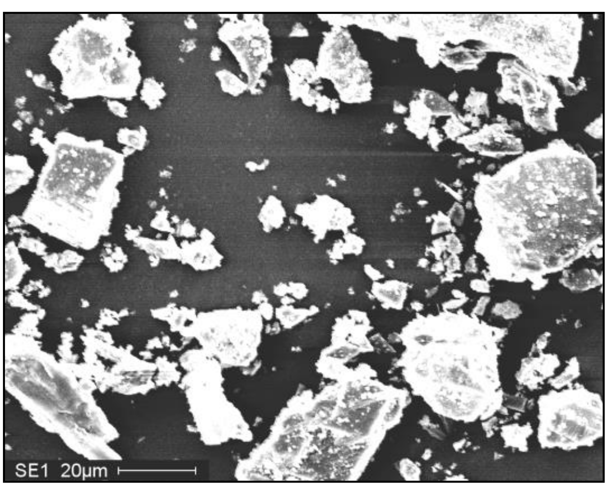


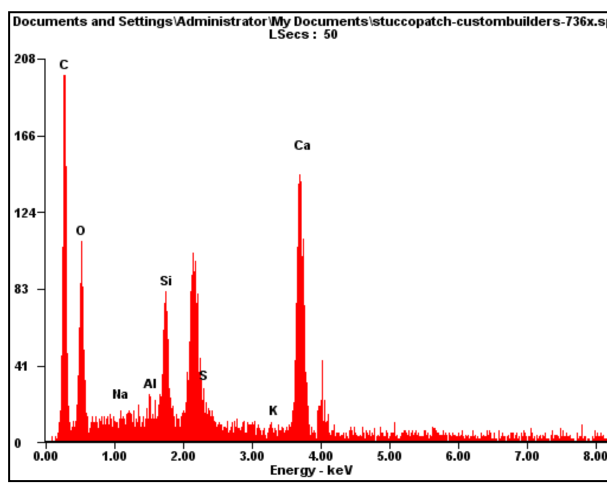


PC – 1 Drywall patch – 736x



Sheetrock Easy Sand Brand 736x

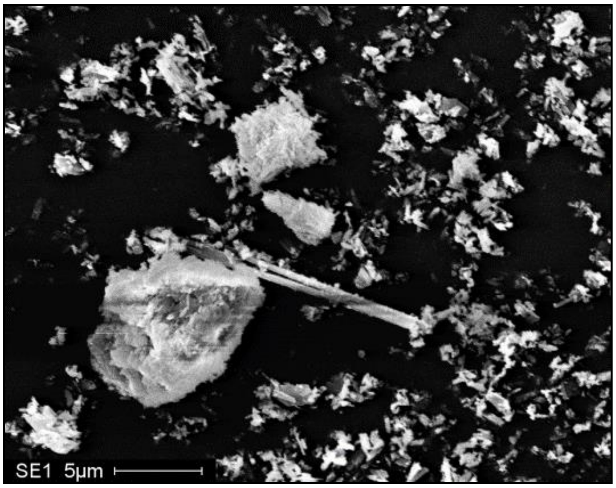


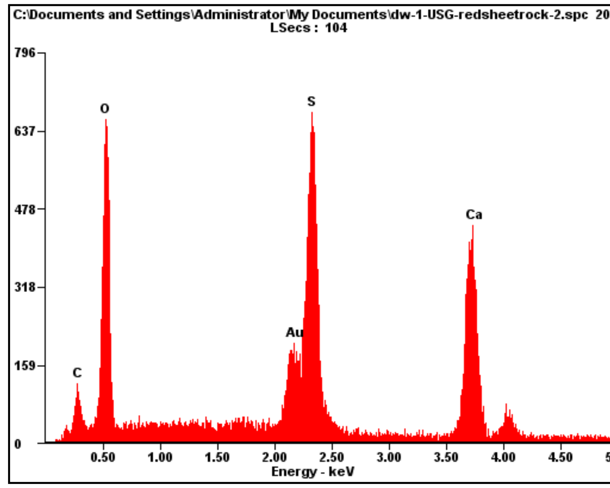


Stucco Patch – Custom Builders – 736x

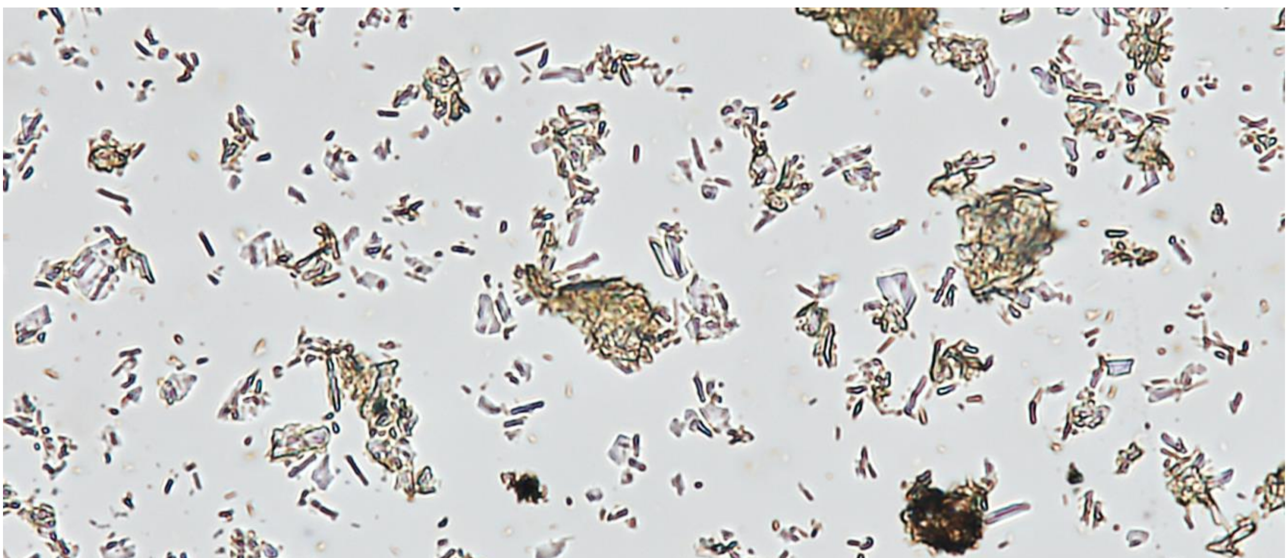
COMMON EXAMPLE PARTICLES

Example particles images & X-ray spectra – Drywall Material

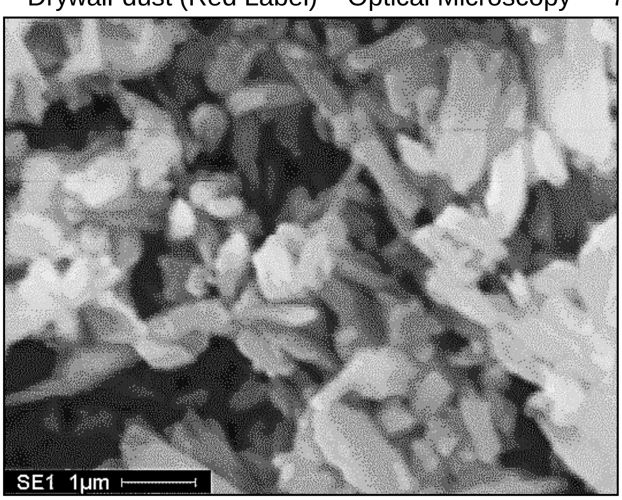


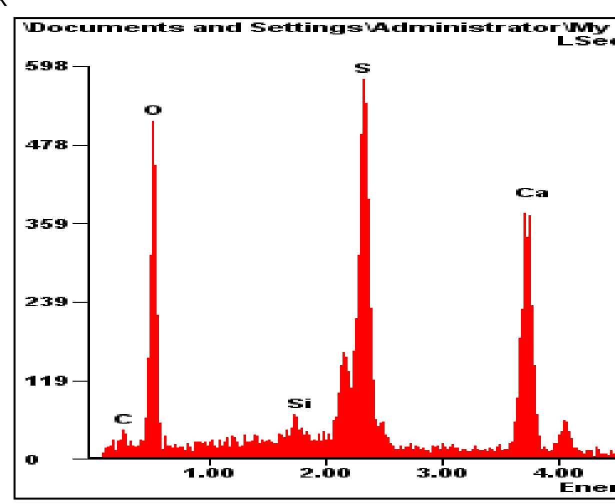


US Gypsum (Red label) - Calcium Sulfate – 400x



Drywall dust (Red Label) – Optical Microscopy - ~700x

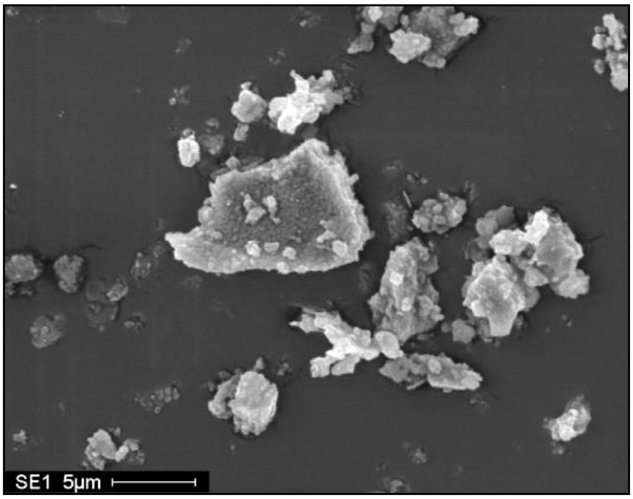


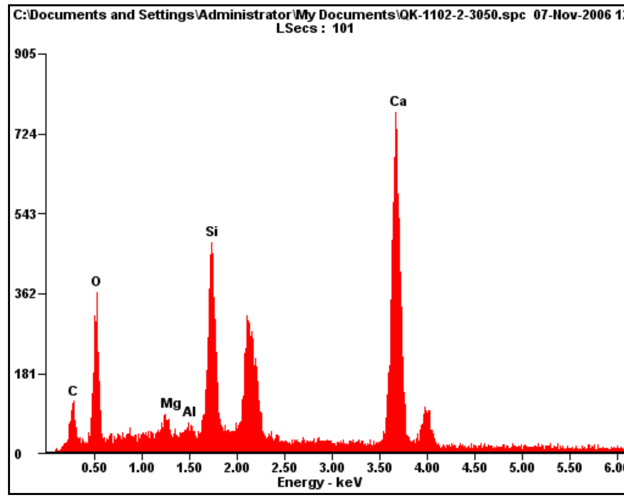


US Gypsum (Green label). 12,000X showing the crystal structure.

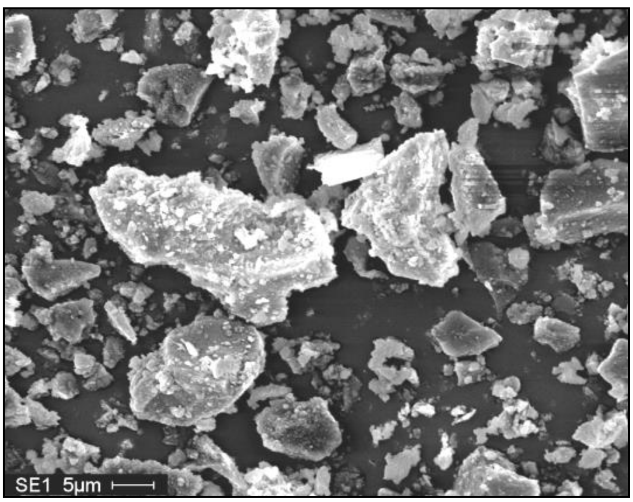
COMMON EXAMPLE PARTICLES

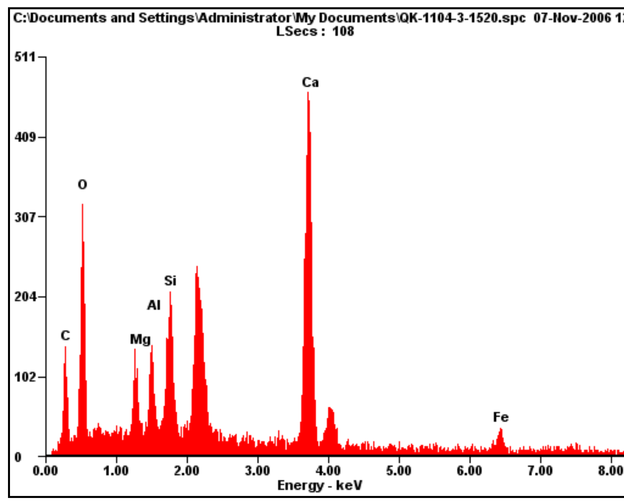
Example particles images & X-ray spectra – Different concrete mixes



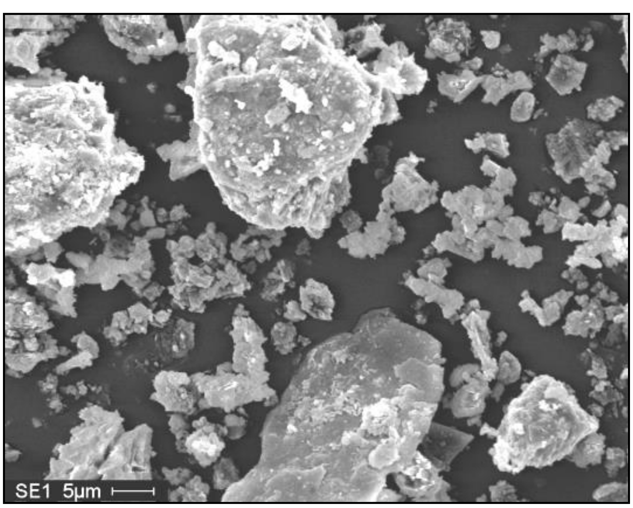


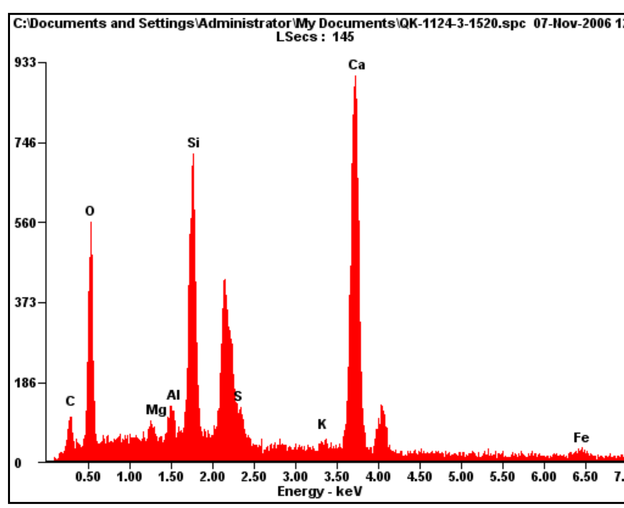
Quik krete 1102 – 3050x





Quik krete 1104 – 1520x

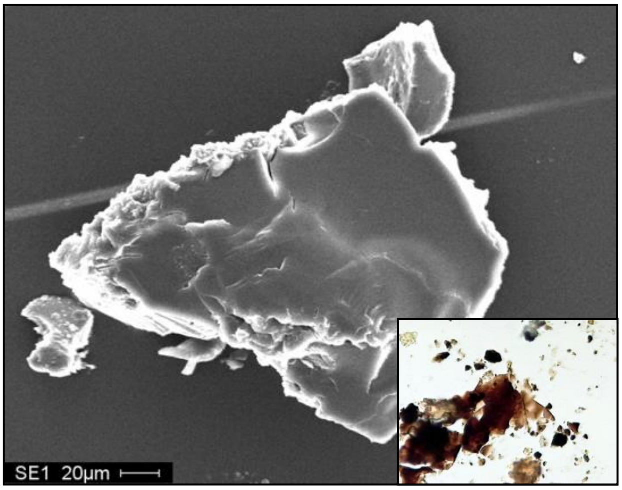


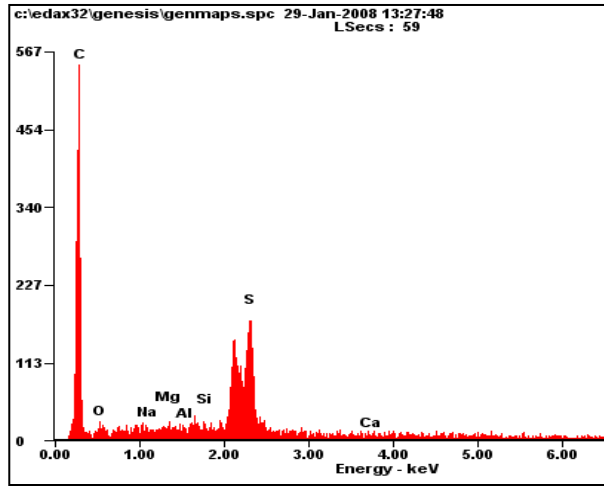


Quik krete 1124 – 1520x

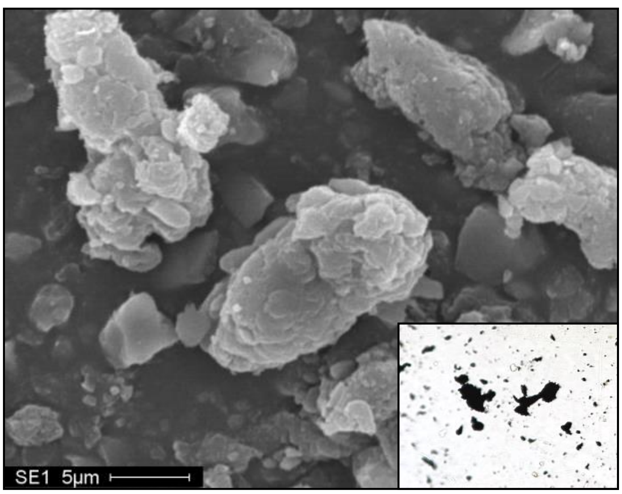
COMMON EXAMPLE PARTICLES

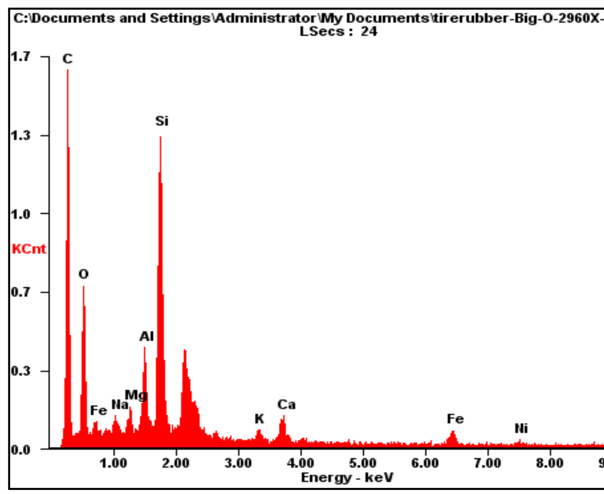
Example particles images & X-ray spectra – Carbonaceous road related



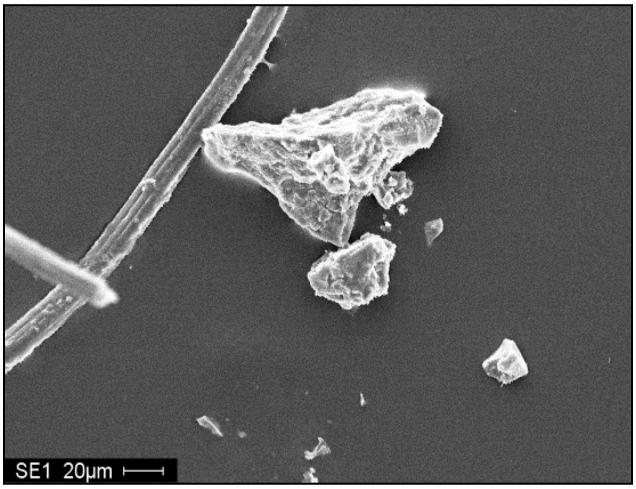


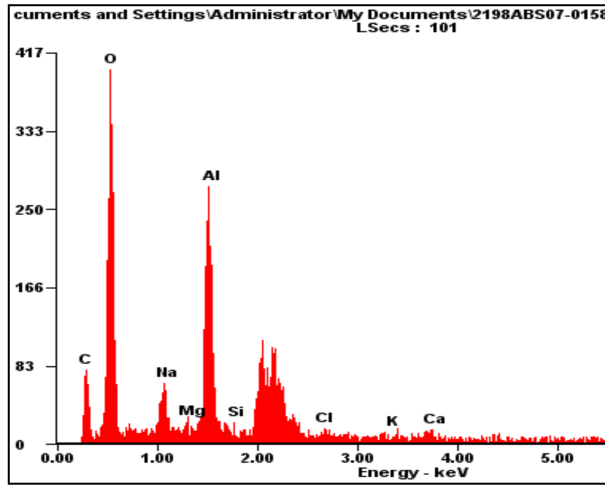
Road asphalt



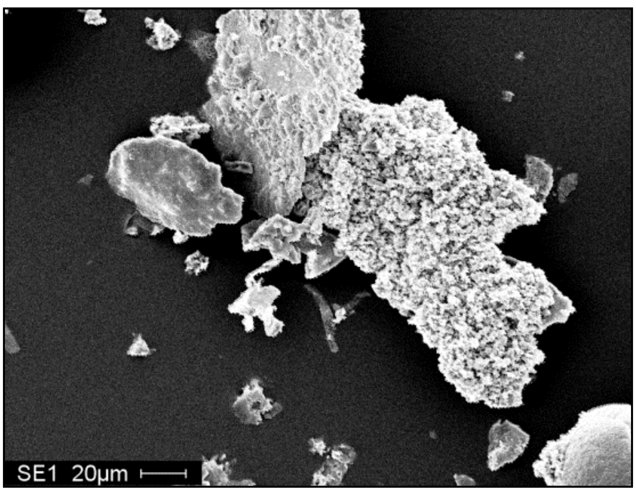


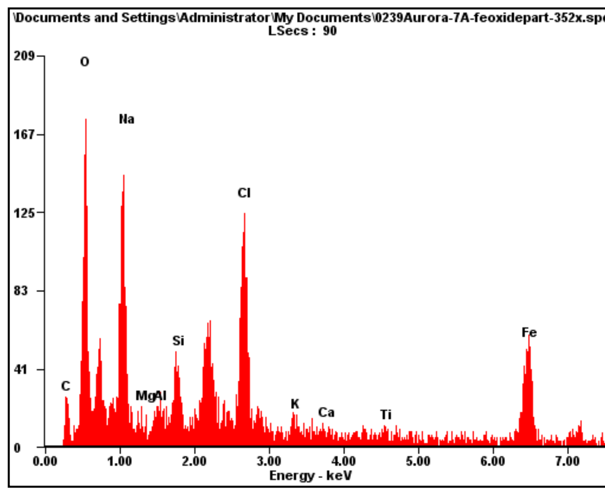
Tire rubber – Big-O tires – 3000x



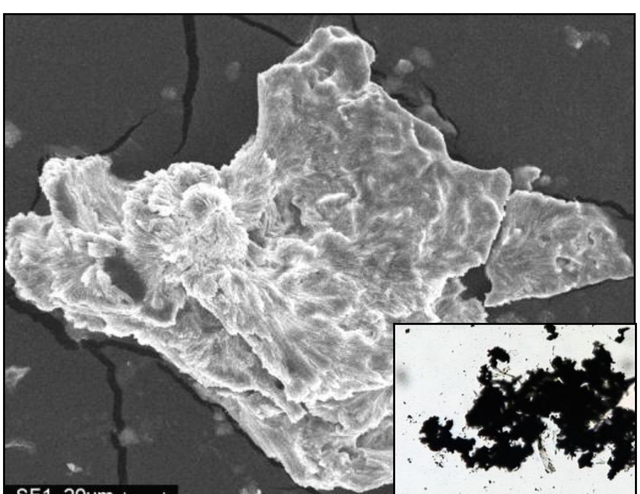


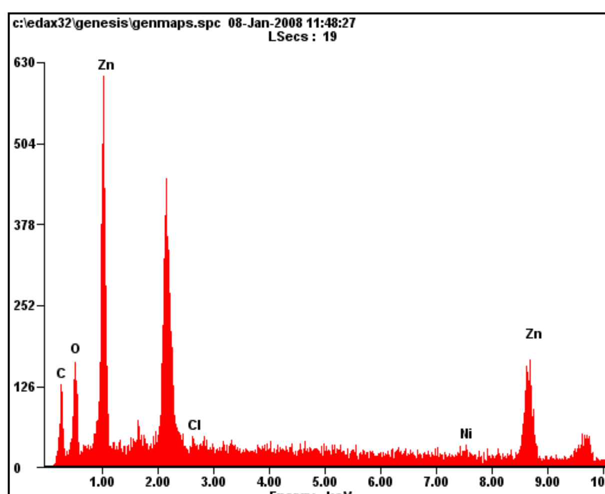
Aluminum HVAC system oxide





Iron oxide / chloride – Water corrosion

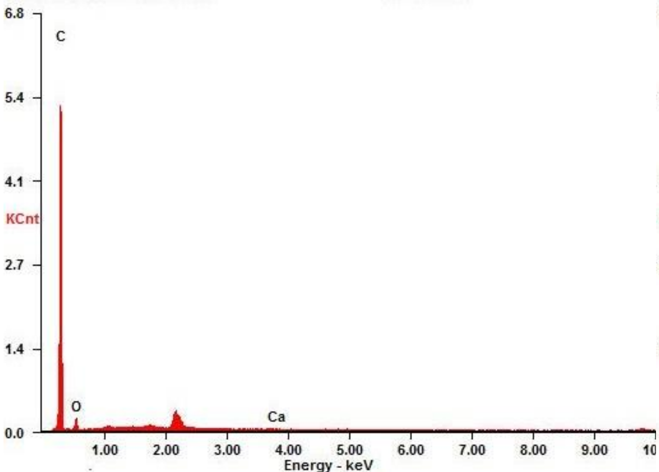




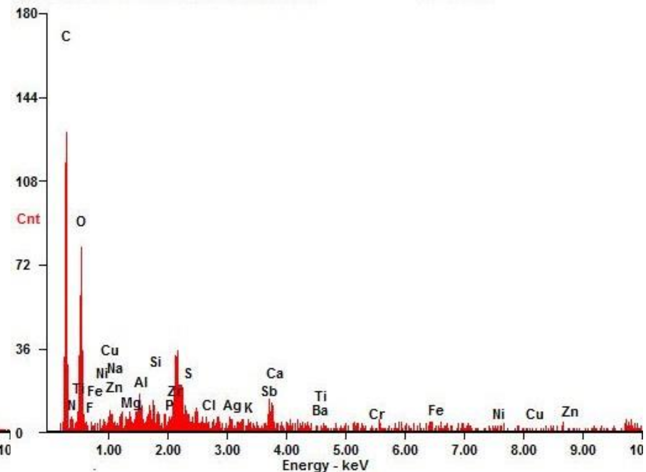
Zinc oxide – Galvanized ducting corrosion

EXAMPLE X-RAY Automated SEM PARTICLE CLASSIFICATIONS

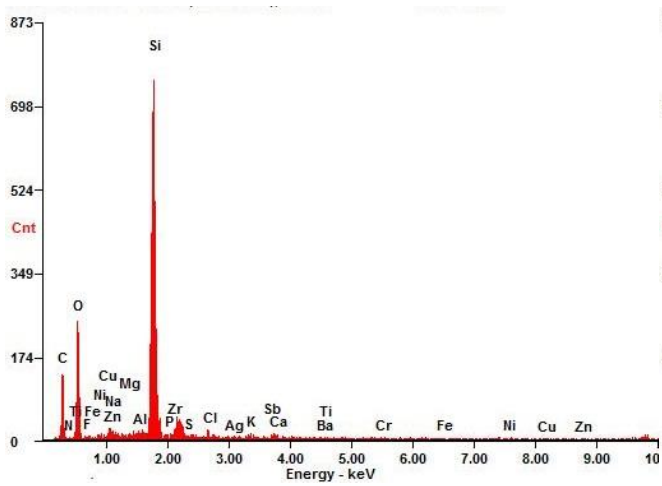
Common indoor / outdoor particle chemistry



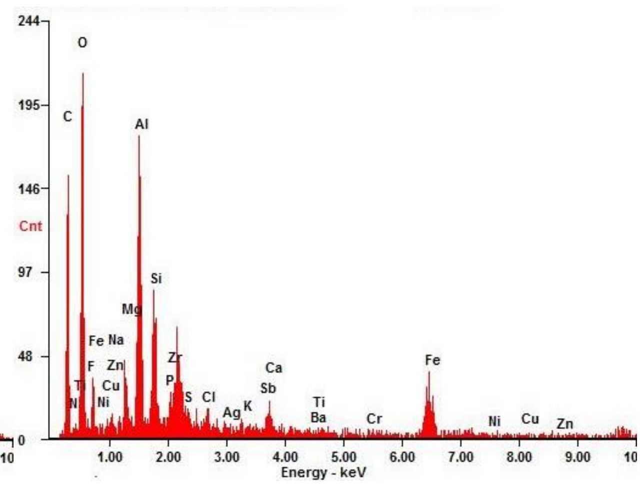
H carbon (Possible combustion char / soot)



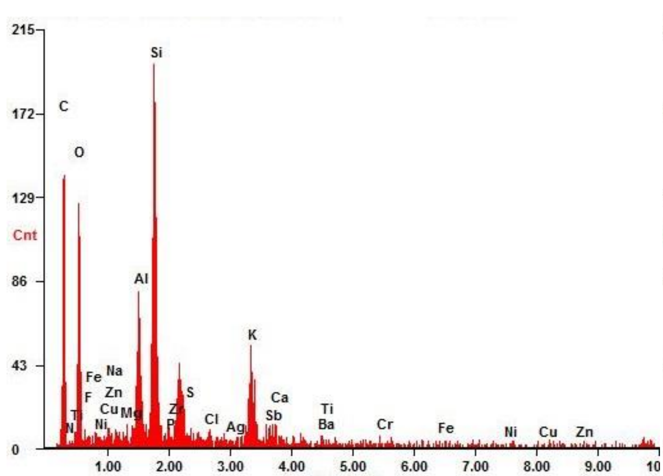
M carbon (biogenic / cellulosic materials)



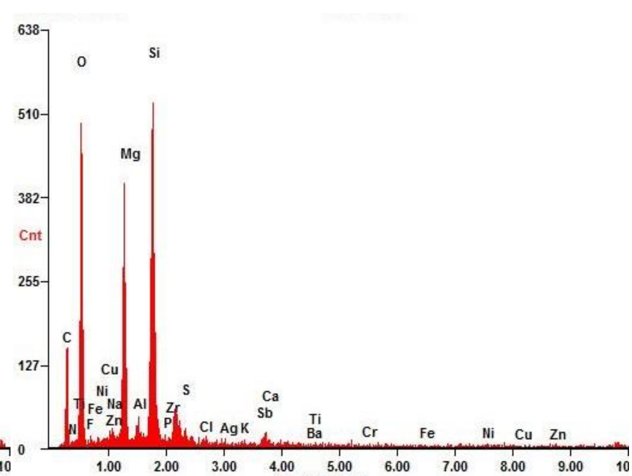
Quartz-like / Si oxide



M Al silicate



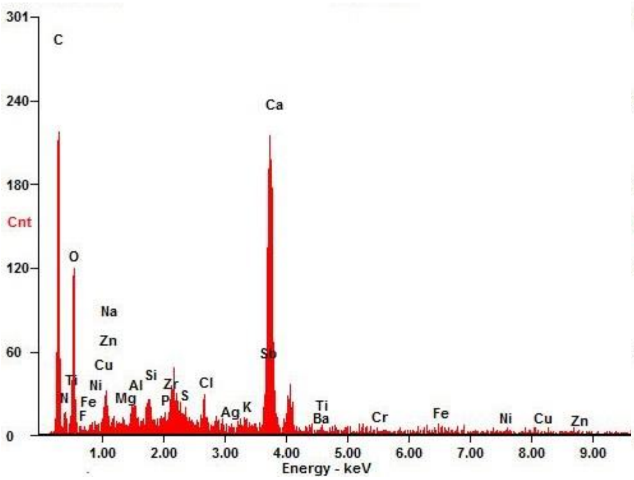
AlK silicate



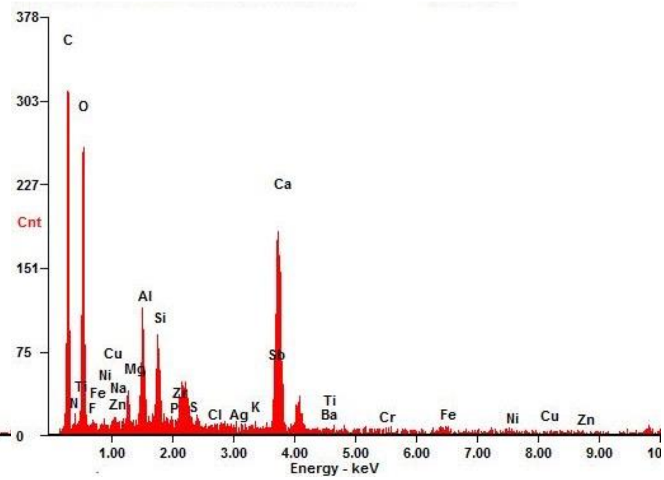
Mg silicate

EXAMPLE X-RAY Automated SEM PARTICLE CLASSIFICATIONS

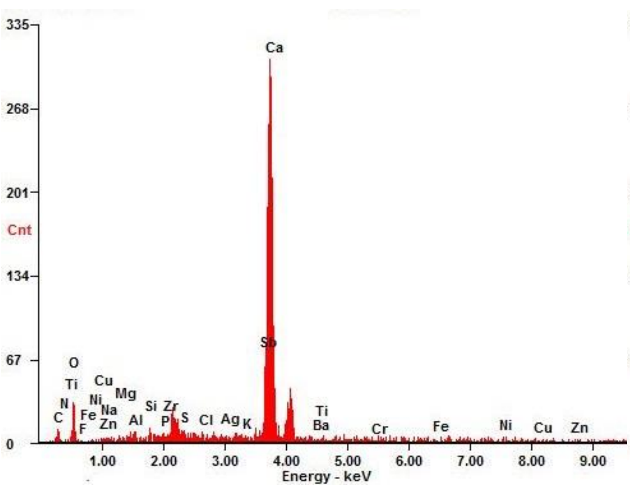
Common indoor / outdoor particle chemistry



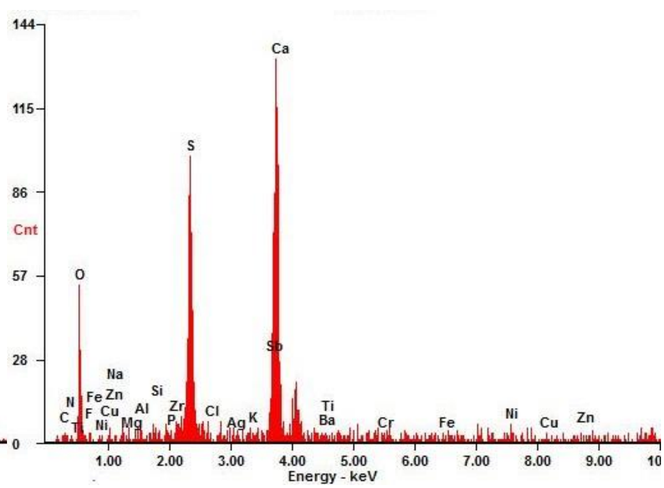
Ca carbonate



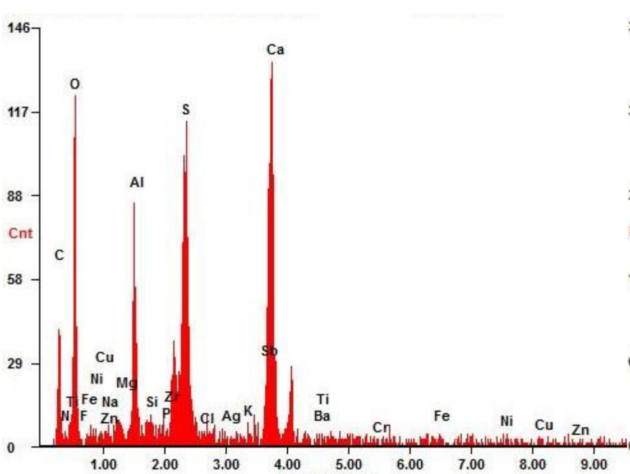
M Ca carbonate



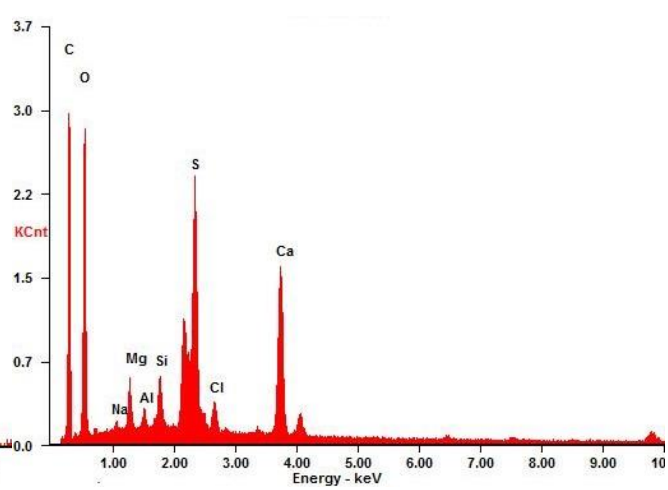
Ca oxide / Ca Oxalate



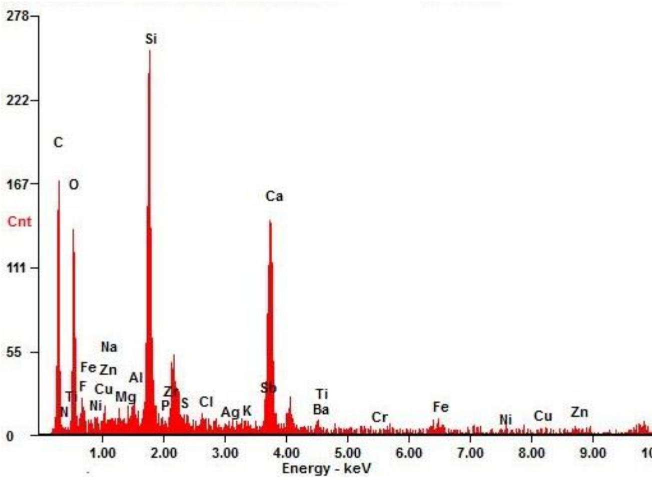
Ca sulfate



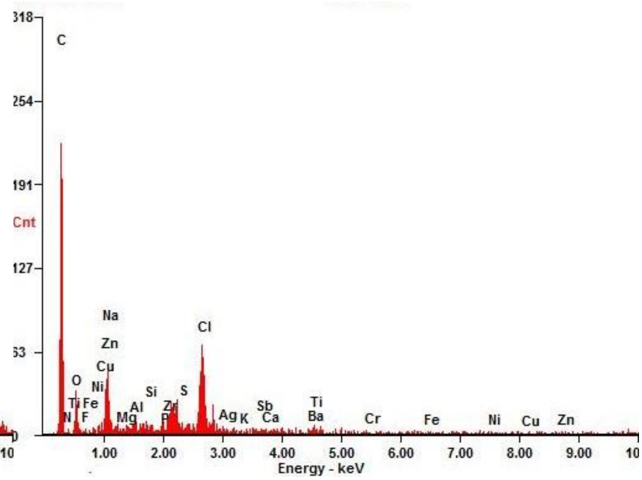
M Ca sulfate



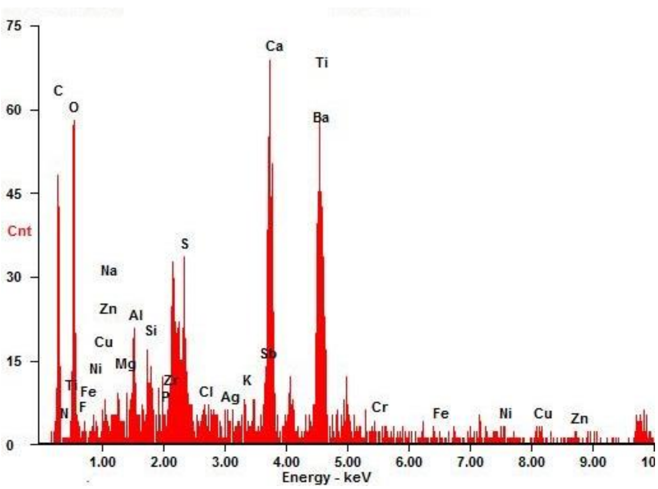
M Ca sulfate (Monokote fireproofing)



Ca silicate



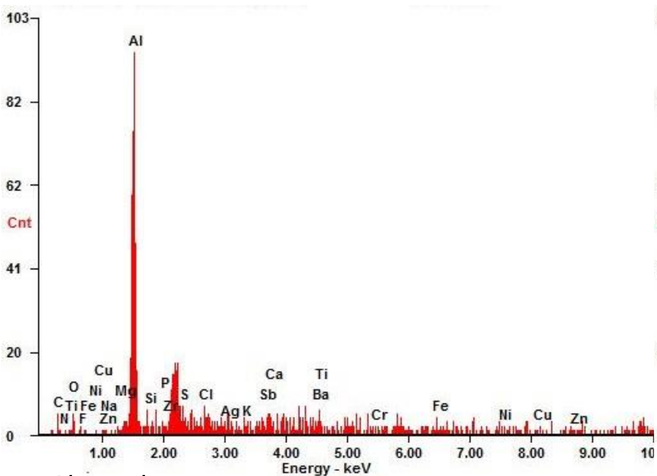
Na chloride (<10um particle)



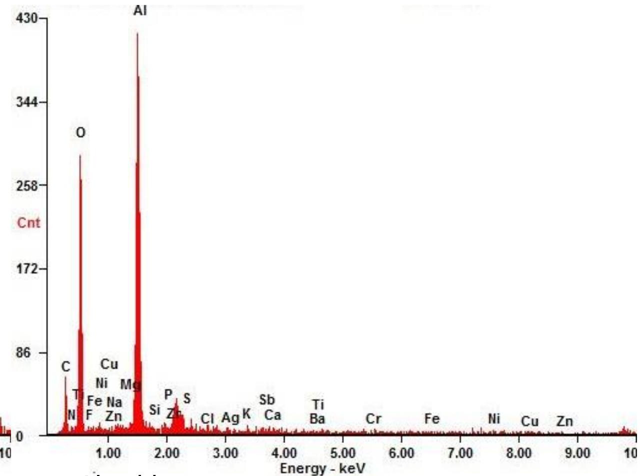
M CaTi oxide (paint)

EXAMPLE X-RAY Automated SEM PARTICLE CLASSIFICATIONS

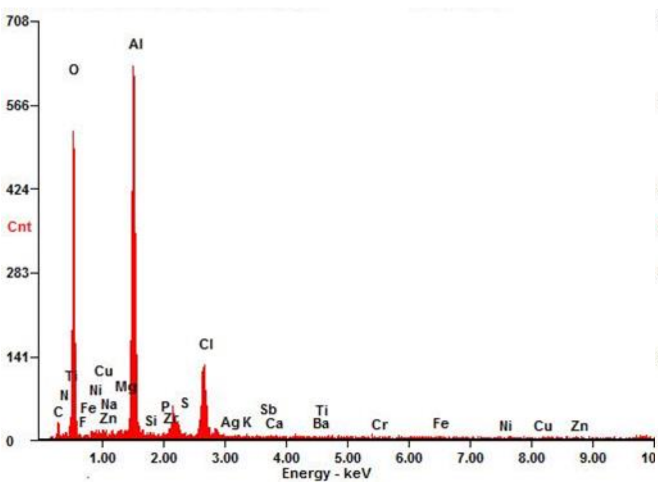
Common HVAC corrosion particle chemistry



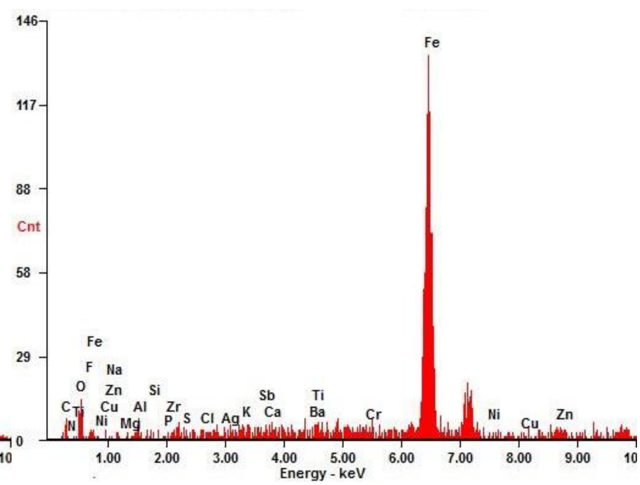
Al metal



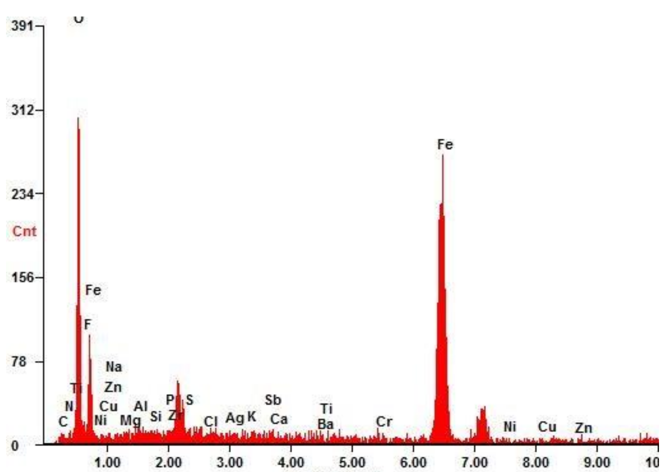
Al oxide



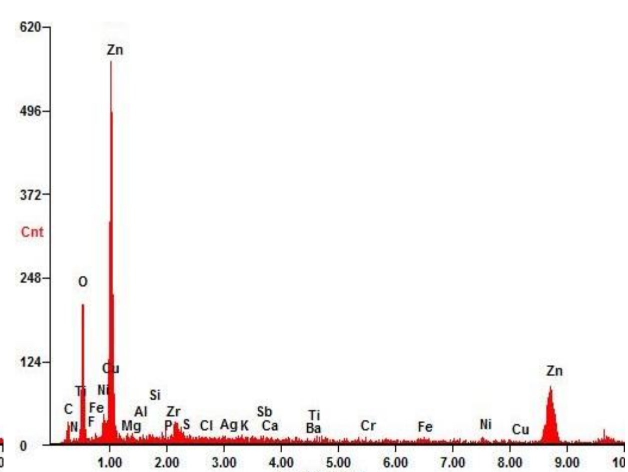
AlCl oxide (water corrosion)



Fe metal



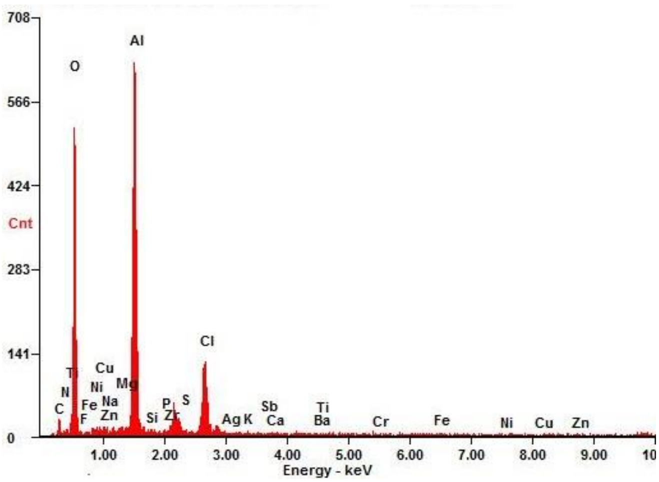
Fe oxide



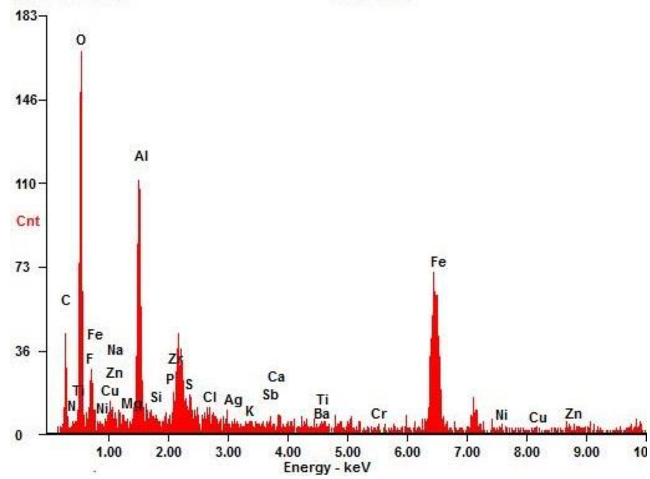
Zn oxide

EXAMPLE X-RAY Automated SEM PARTICLE CLASSIFICATIONS

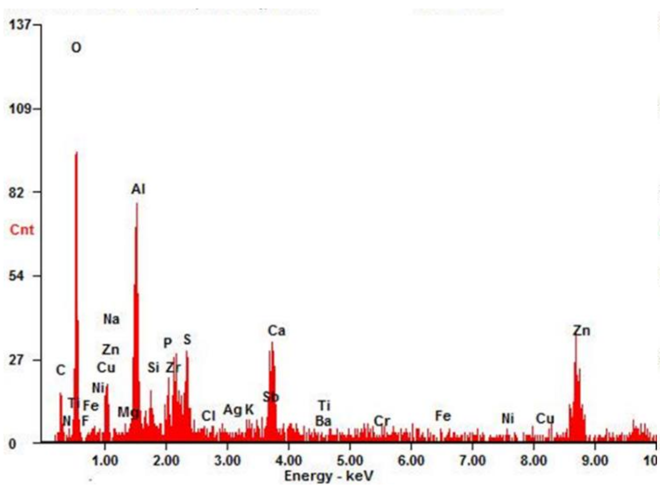
Common HVAC corrosion particle chemistry



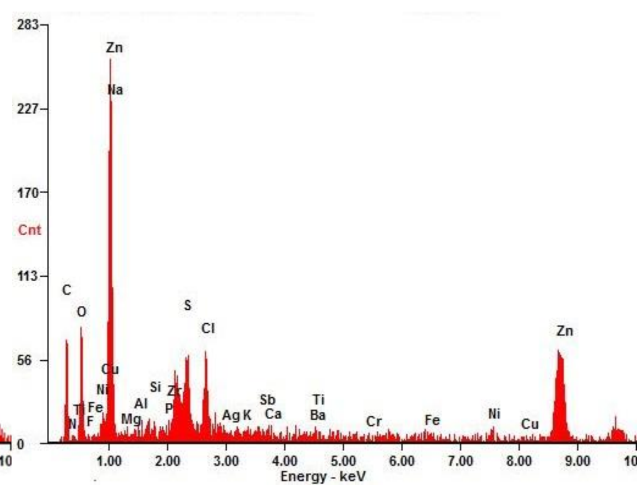
AlCl oxide (Water / electrolytic corrosion)



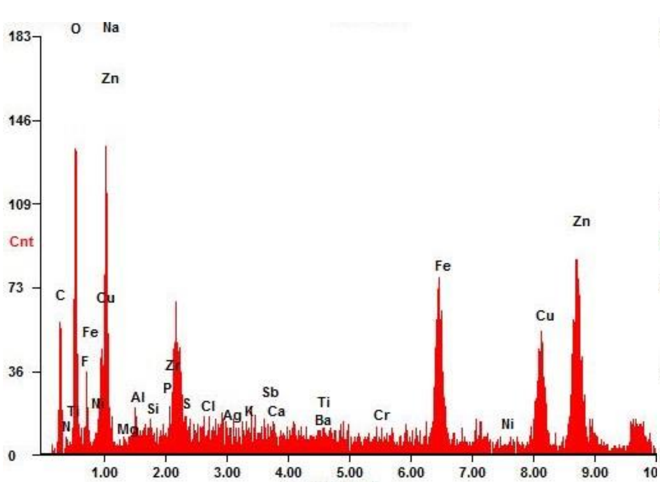
AlFe oxide



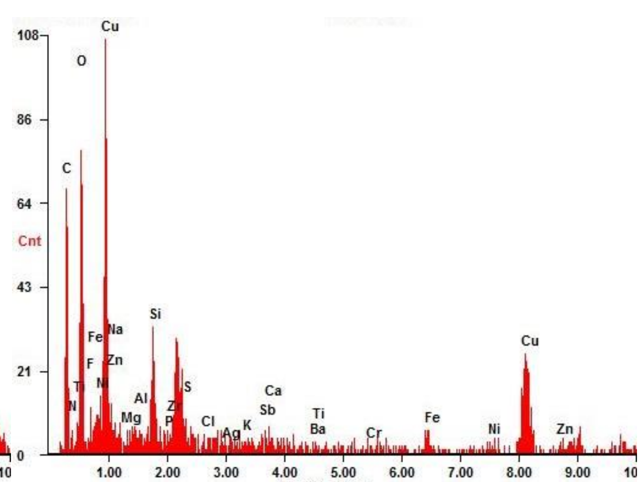
M AlZn oxide



M ZnCl oxide



FeCuZn oxide



M Cu oxide

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