ASSESSING FIRE RESIDUE "CONTAMINATION" AND IAQ

Evolving fire residue testing methods & dust analysis methods

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WHAT IS DUST? – A Forensic IAQ Perspective

Dust is a complex mixture of "decomposing" and different sized particles from a wide range of biological, physiological, meteorological, chemical, geological, and frictional processes.

The story or history of individual particles is masked by the flood of other particles comprising what looks like a uniform "speck of dust".

The human bias is to look for patterns of uniformity where they may not exist.

"Fire residue particles" are the ultimate challenge for both analytical and microscopic analysis methods.

The need for better sampling and analysis methods has sparked a revolution in thinking about how we analyze "dust" samples.

THE "DUST" ANALYSIS PARADOX

CHEMICAL METHODS

1. Most "analytical chemical dust methods" report chemical constituents as a composited "bulk" analysis.

2. The analysis is an "average" of 1000's -1,000,000's individual particles. The result reflects a homogenous result where one may not exist.

3. This fools us into using a uniform measure of comparison where no uniform measure may actually apply.

THE "DUST" ANALYSIS PARADOX - 2

MICROSCOPIC METHODS

4. "Microscopy" methods can only look at a small number of individual particles (10's-100's). The resulting data is "extrapolated" to simulate an average sample composition.

5. As a result, a reliable "reconstruction" of a bulk sample by microscopic methods has historically been time consuming, highly variable, cost prohibitive, and unavailable.

6. The advantage is, particles within the sample can be "classified".

THE "DUST" ANALYSIS PARADOX - 3

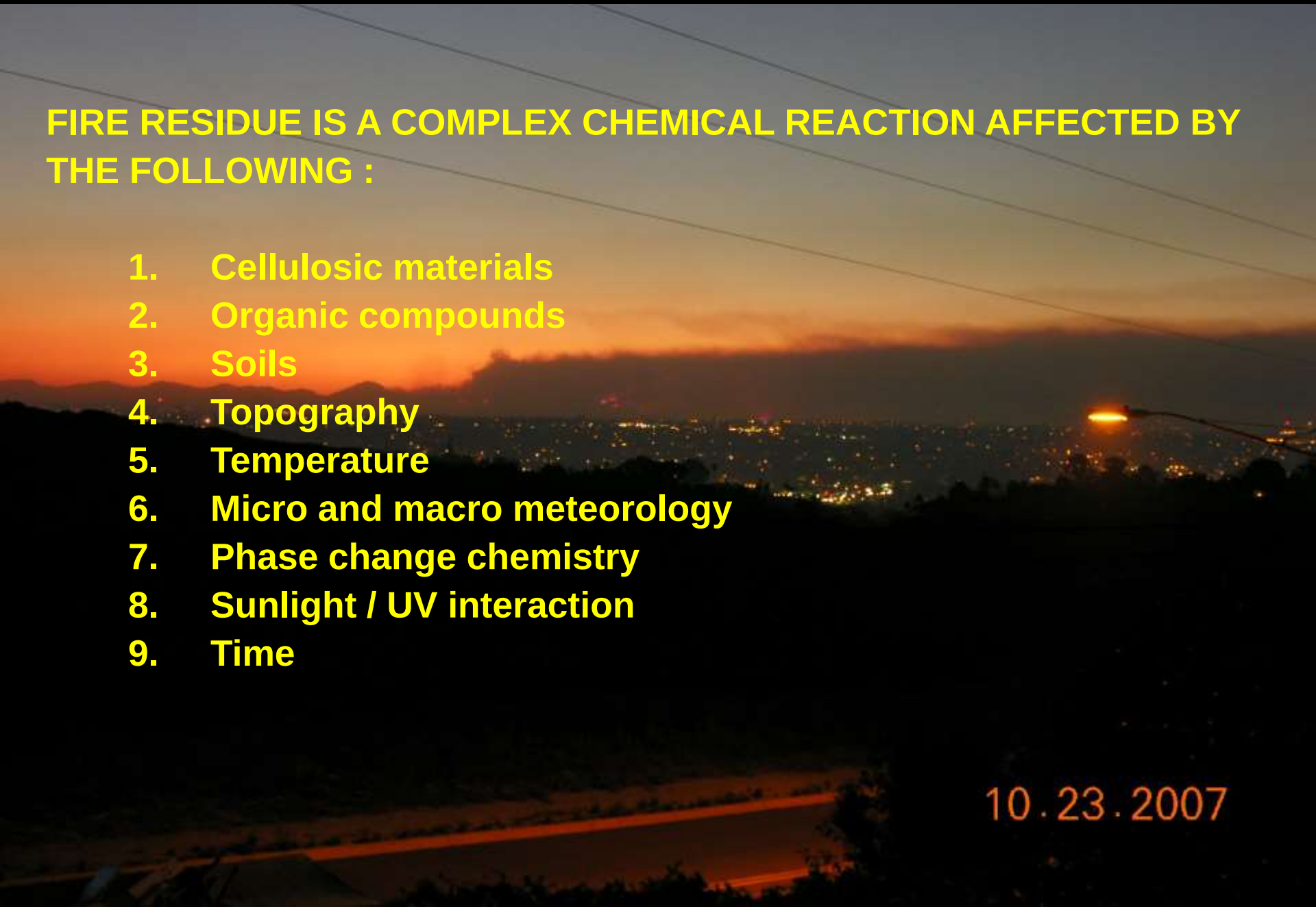
WHAT DOES THIS MEAN ?

7. **"Analytical chemical methods" provide good accuracy & precision, but cannot determine sample source or origin.**

8. **Conversely, "traditional microscopic methods" have relatively poor accuracy & precision, but can sometimes determine sample source or origin.**

9. **These traditional limitations on "traditional" microscopic particle analysis have limited its use.**

WHAT IS FIRE RESIDUE ?



FIRE RESIDUE IS A COMPLEX CHEMICAL REACTION AFFECTED BY THE FOLLOWING :

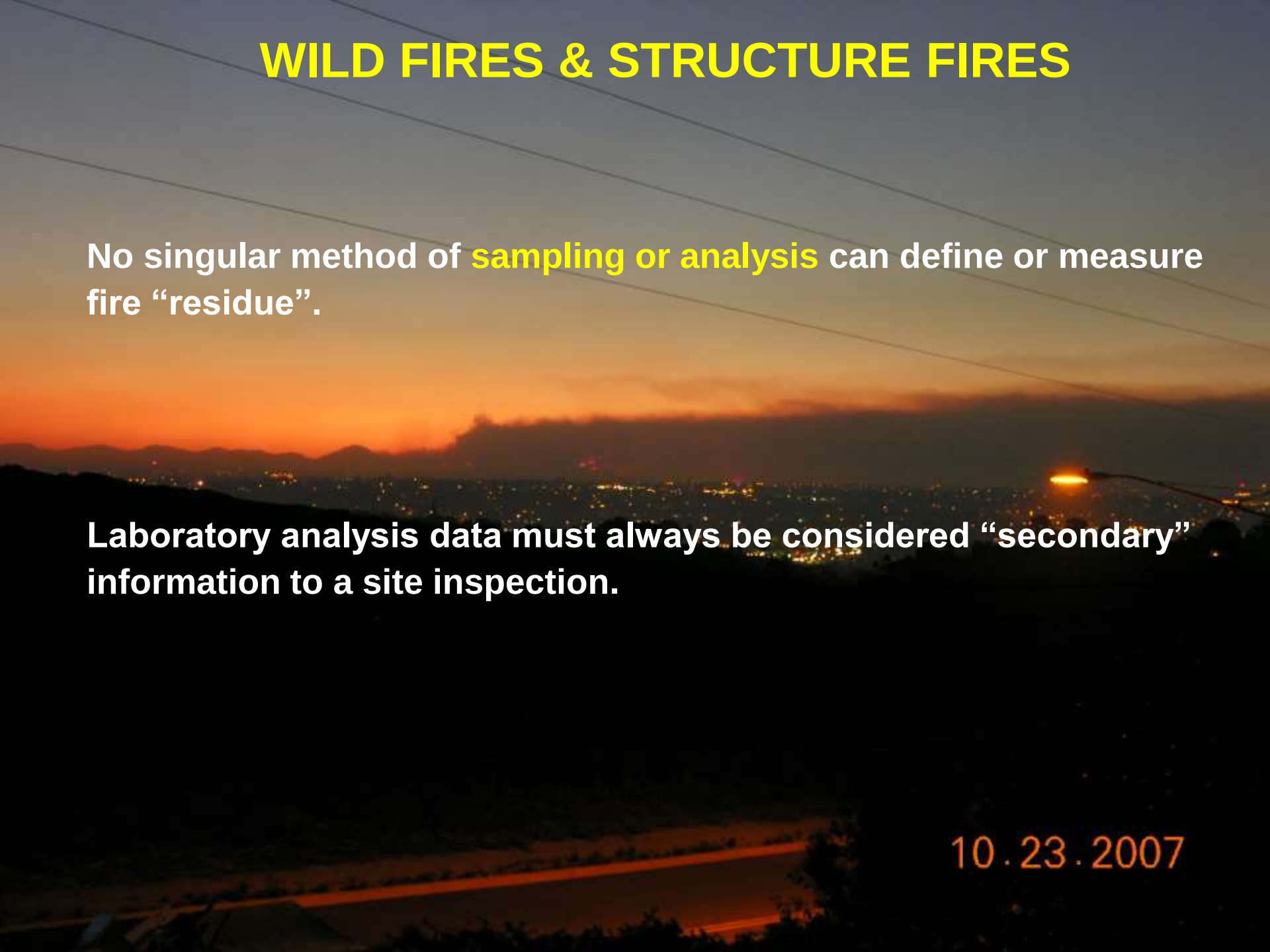
1. Cellulosic materials
2. Organic compounds
3. Soils
4. Topography
5. Temperature
6. Micro and macro meteorology
7. Phase change chemistry
8. Sunlight / UV interaction
9. Time

THE COMPOSITION OF FIRE RESIDUE

- Transitional acid gases
- Volatile and semi-volatile organic compounds
- Metals
- Combustion particles
- Re-entrained soil particles

There are significant differences between wildfire & structure fire chemistry.

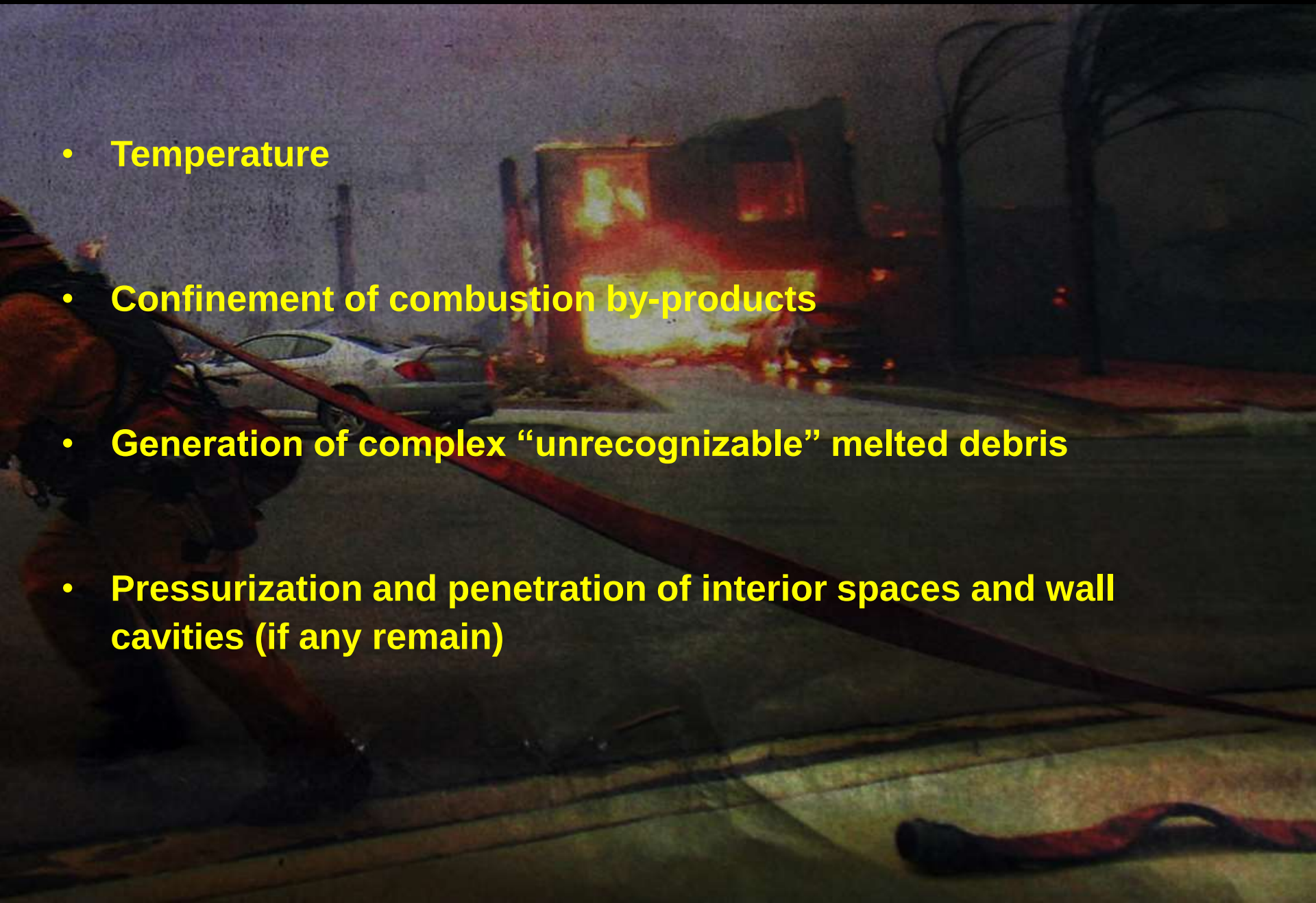
WILD FIRES & STRUCTURE FIRES



No singular method of sampling or analysis can define or measure fire "residue".

Laboratory analysis data must always be considered "secondary" information to a site inspection.

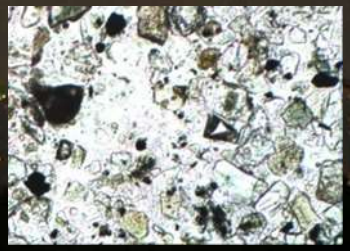
WHY IS A STRUCTURE FIRE DIFFERENT FROM A WILDFIRE ?



- Temperature
- Confinement of combustion by-products
- Generation of complex “unrecognizable” melted debris
- Pressurization and penetration of interior spaces and wall cavities (if any remain)

CHEMISTRY DISTRIBUTION OF A WILDFIRE

Reactive <u>acidic</u> volatile gaseous compounds
Ozone production
Potential PAH's & PNA's
Condensed aciniform "soot particles"



Char particles & low volatile organics – **Ash particles (corrosive salts)**

Fire VOCs Residence Time

- **Hours –**
  - **CO, CO_2, NO_x, SO_2, cyanide, light inorganic acids (HCl, HF, etc.)**
- **Days –**
  - **Acrolein, acetonitrile, furfural, formaldehyde**
- **Weeks / months –**
  - **Cresols, guaicols, phenols, salicaldehydes**
- **Months to years -**
  - **PAHs (naphthalene, 2-methylnaphthalene, acenaphthylene), biphenyl, syringols, levoglucosan**

Levoglucosan as a "Wildfire" Biomass Marker

The major organic components of smoke particles are from the breakdown of cellulose.

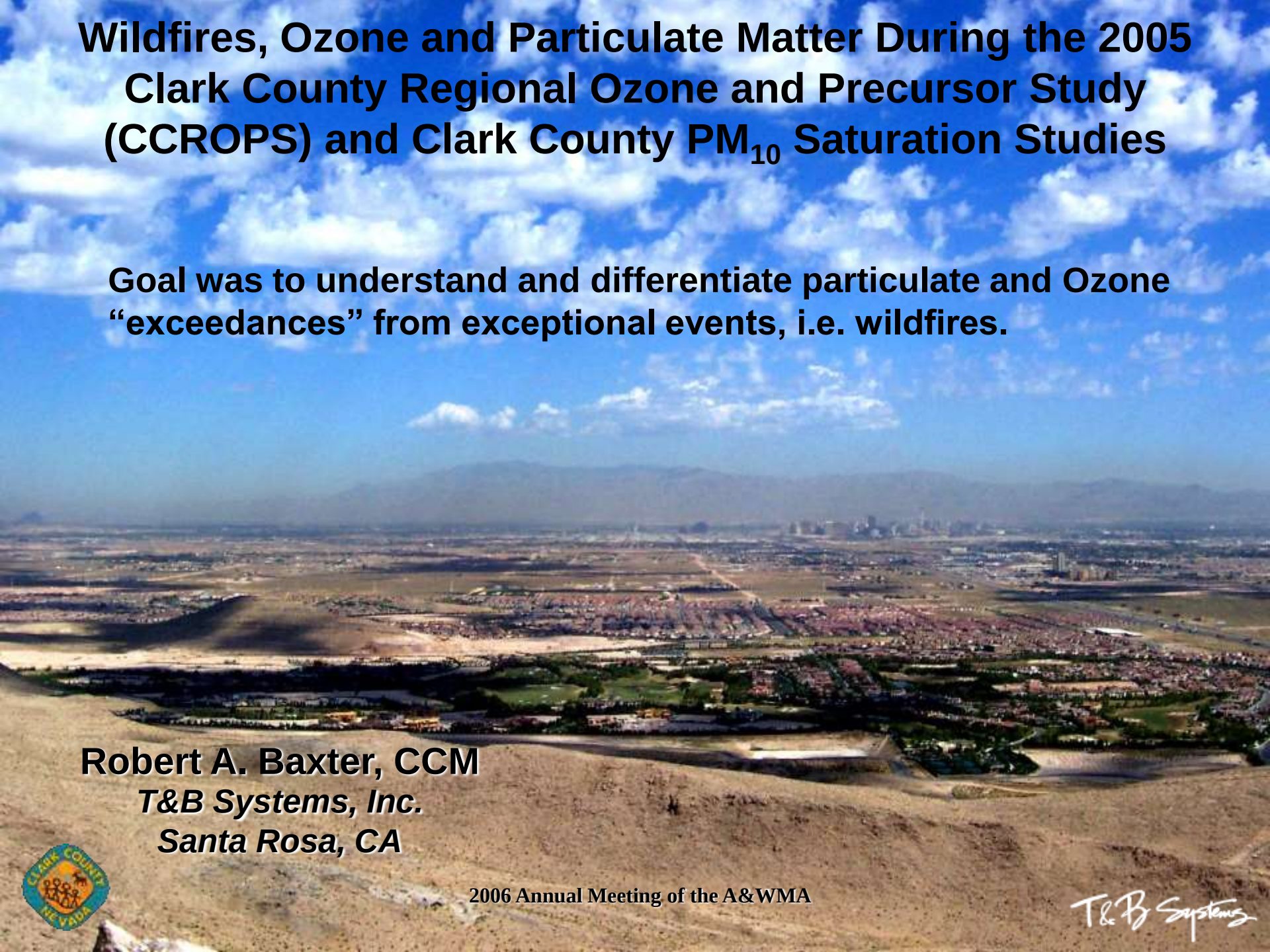
Levoglucosan, a degradation product from cellulose can be utilized as an indicator for the presence of emissions from biomass burning in samples of atmospheric fine particulate matter.

Levoglucosan is proposed as a specific indicator for cellulose in biomass burning emissions. **Levoglucosan is emitted at such high concentrations that it can be detected at considerable distances from the original combustion source.**

Atmospheric Environment Volume 33, Issue 2, January 1999

Wildfires, Ozone and Particulate Matter During the 2005 Clark County Regional Ozone and Precursor Study (CCROPS) and Clark County PM_{10} Saturation Studies

Goal was to understand and differentiate particulate and Ozone "exceedances" from exceptional events, i.e. wildfires.



Robert A. Baxter, CCM

T&B Systems, Inc.

Santa Rosa, CA

2006 Annual Meeting of the A&WMA

MEASUREMENT AIRCRAFT

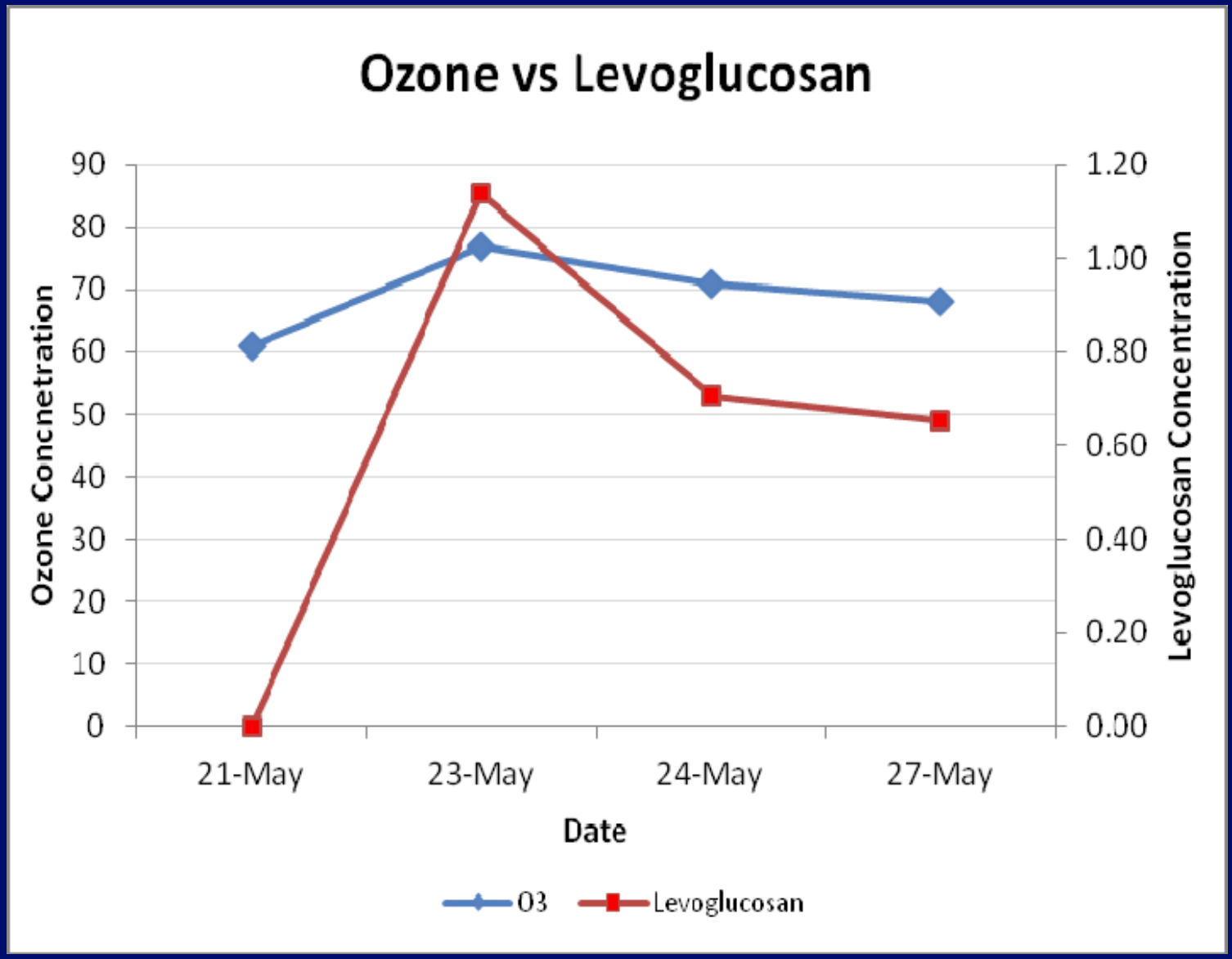
SUMMARY

- Data from CCROPS and PM_{10} study shows a strong correlation between wildfire smoke and ozone
- Ozone production related to age of smoke plume
- Historically high ozone concentrations during wildfires

NOTE: The chemistry of a fire plume "ages" over time.

Ozone also acts as a chemical catalyst

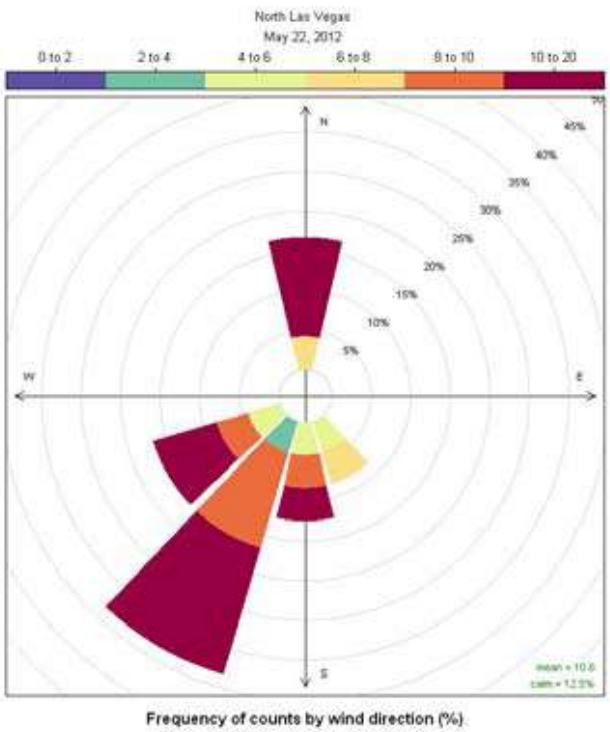
Ozone and Biomass Markers



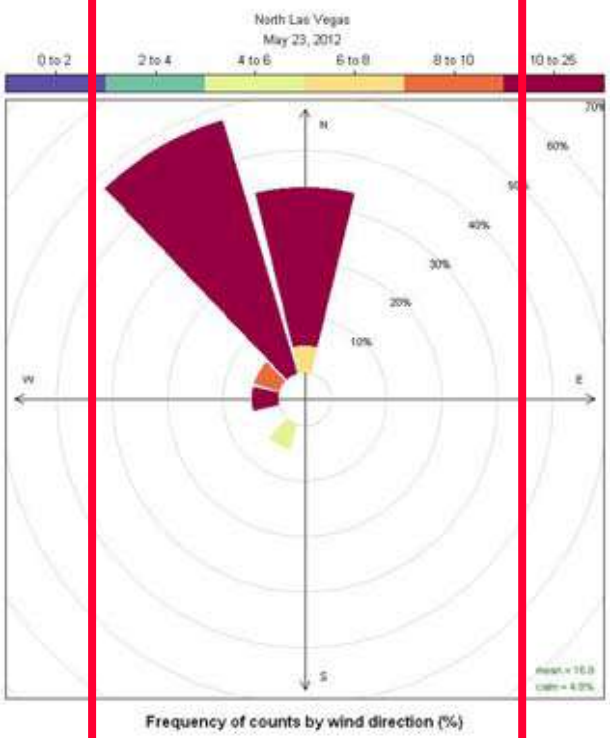
Exceptional Event Documentation for the May 23, 2012, 8-Hour Ozone NAAQS Exceedance in Clark County Caused by a Wildland Fire Event – Clark County – Department of Air Quality

Are You Sampling The Smoke Plume?

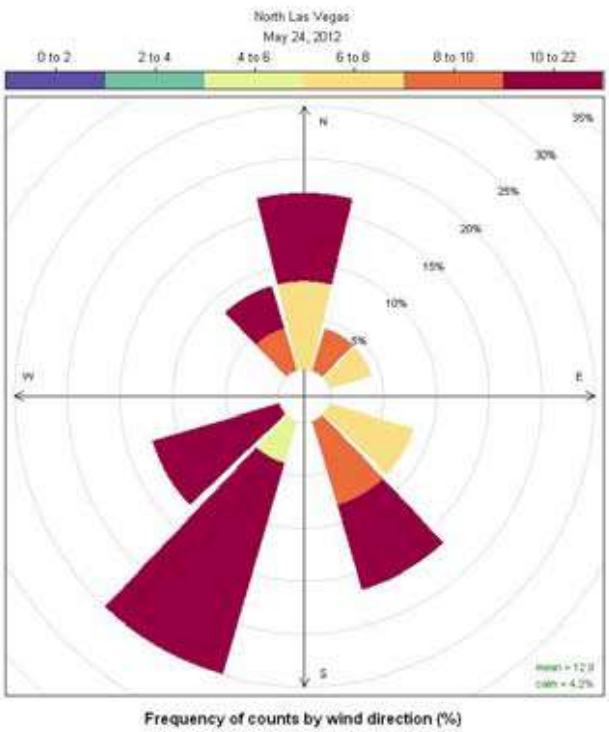
May 22, 2012



May 23, 2012



May 24, 2012

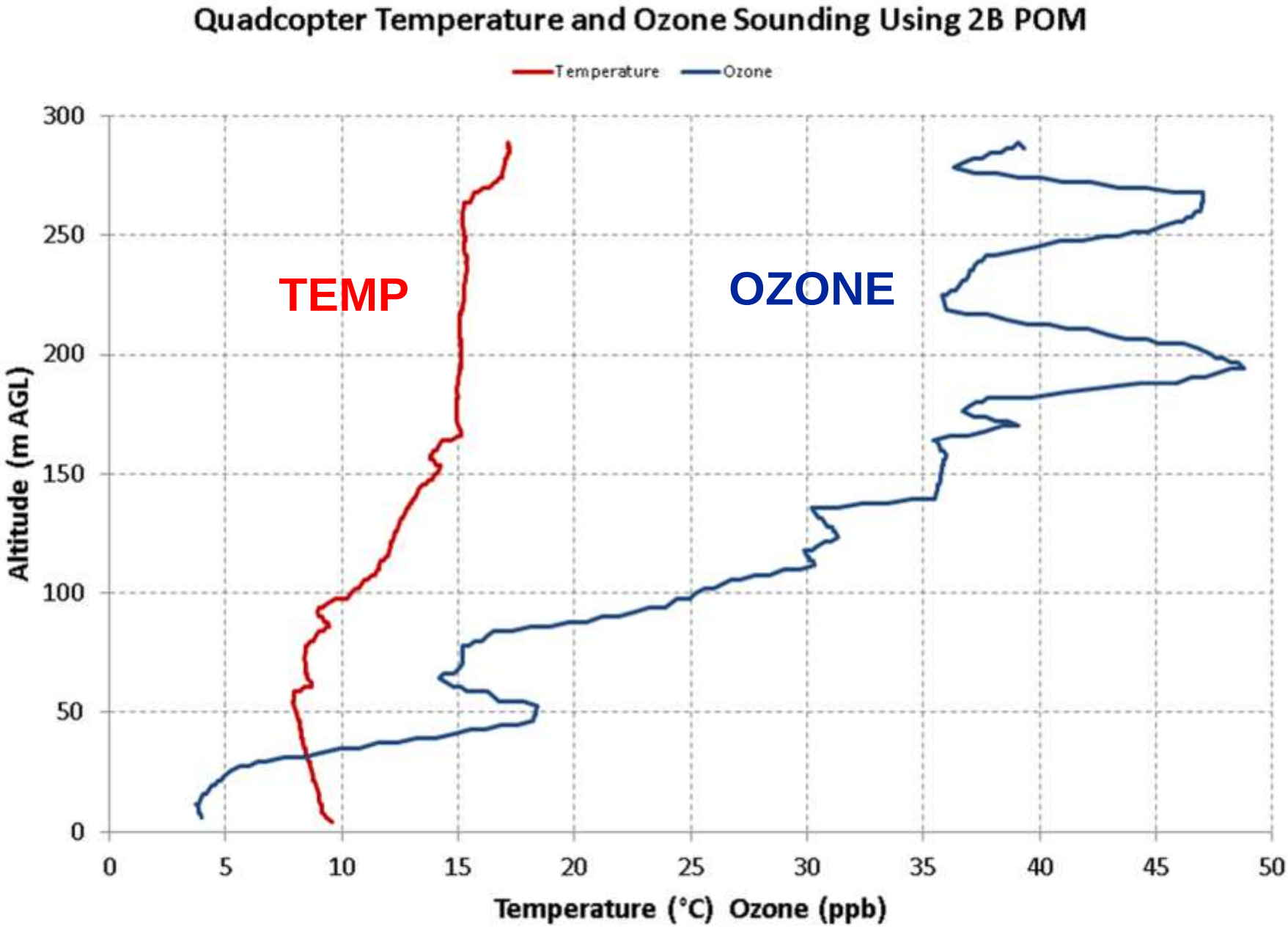


Exceptional Event Documentation for the May 23, 2012, 8-Hour Ozone NAAQS Exceedance in Clark County Caused by a Wildland Fire Event – Clark County – Department of Air Quality

GETTING BETTER SAMPLES

The use of “drones has spawned a revolution in the miniaturization of sensors

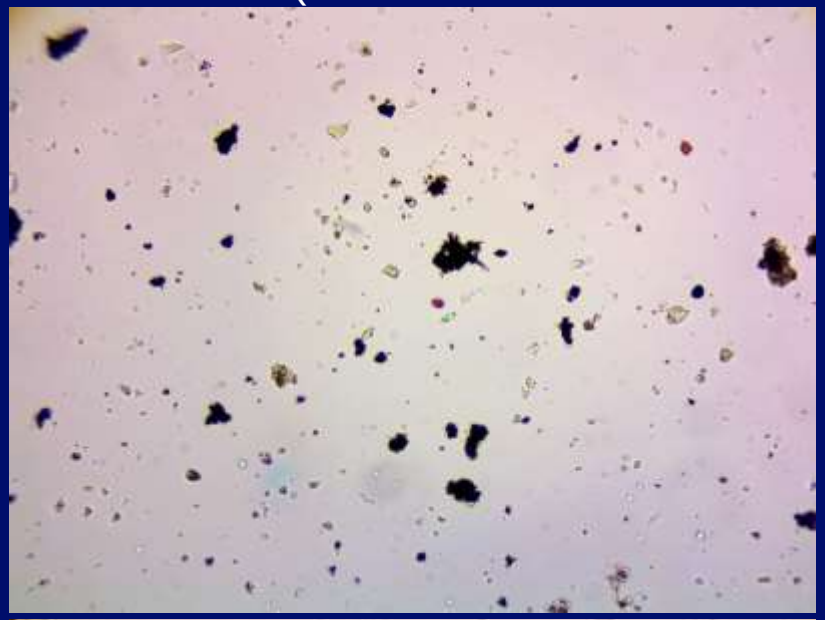
Ozone, MET, Dust, PM_{10} Profile

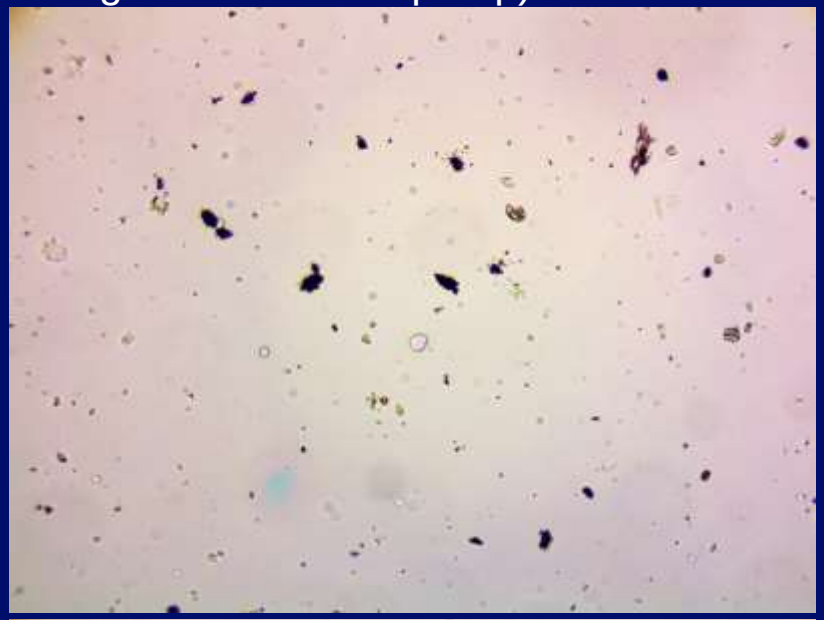

Quadcopter Temperature and Ozone Sounding Using 2B POM
Temperature
Ozone
TEMP
OZONE
Altitude (m AGL)
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
Temperature (°C) Ozone (ppb)

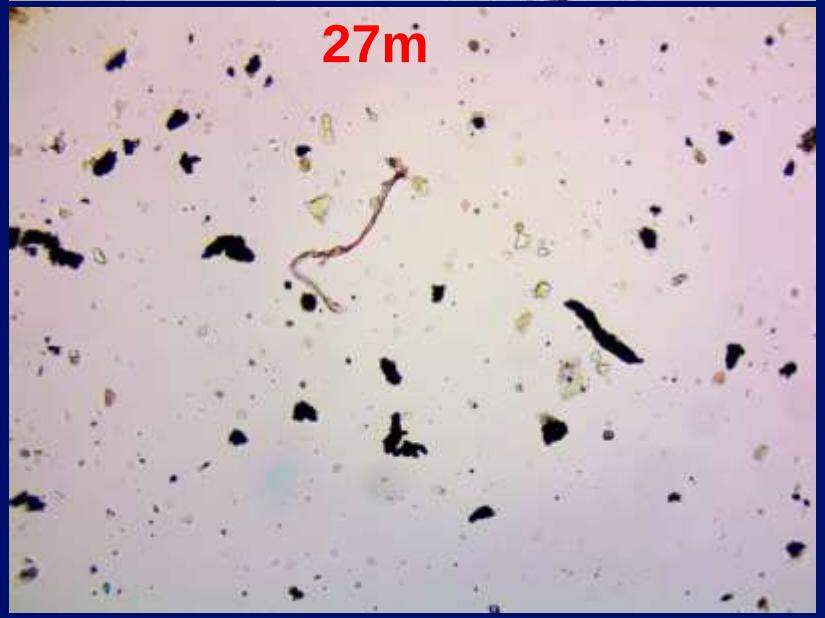
Wildfire residue collected by Quadcopter

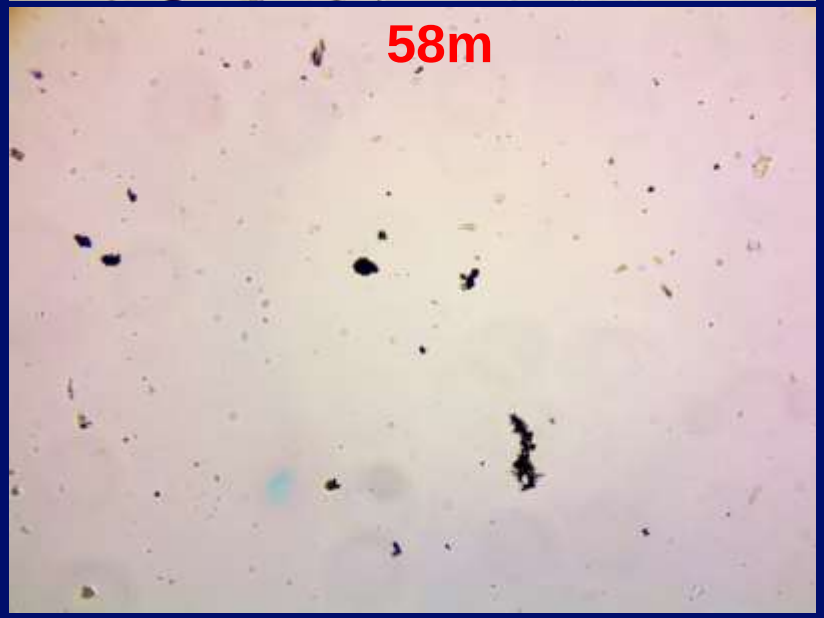
Fireplace burning in a residential neighborhood

(4 minute Air-O-Cell CSI sample using a miniaturized pump)

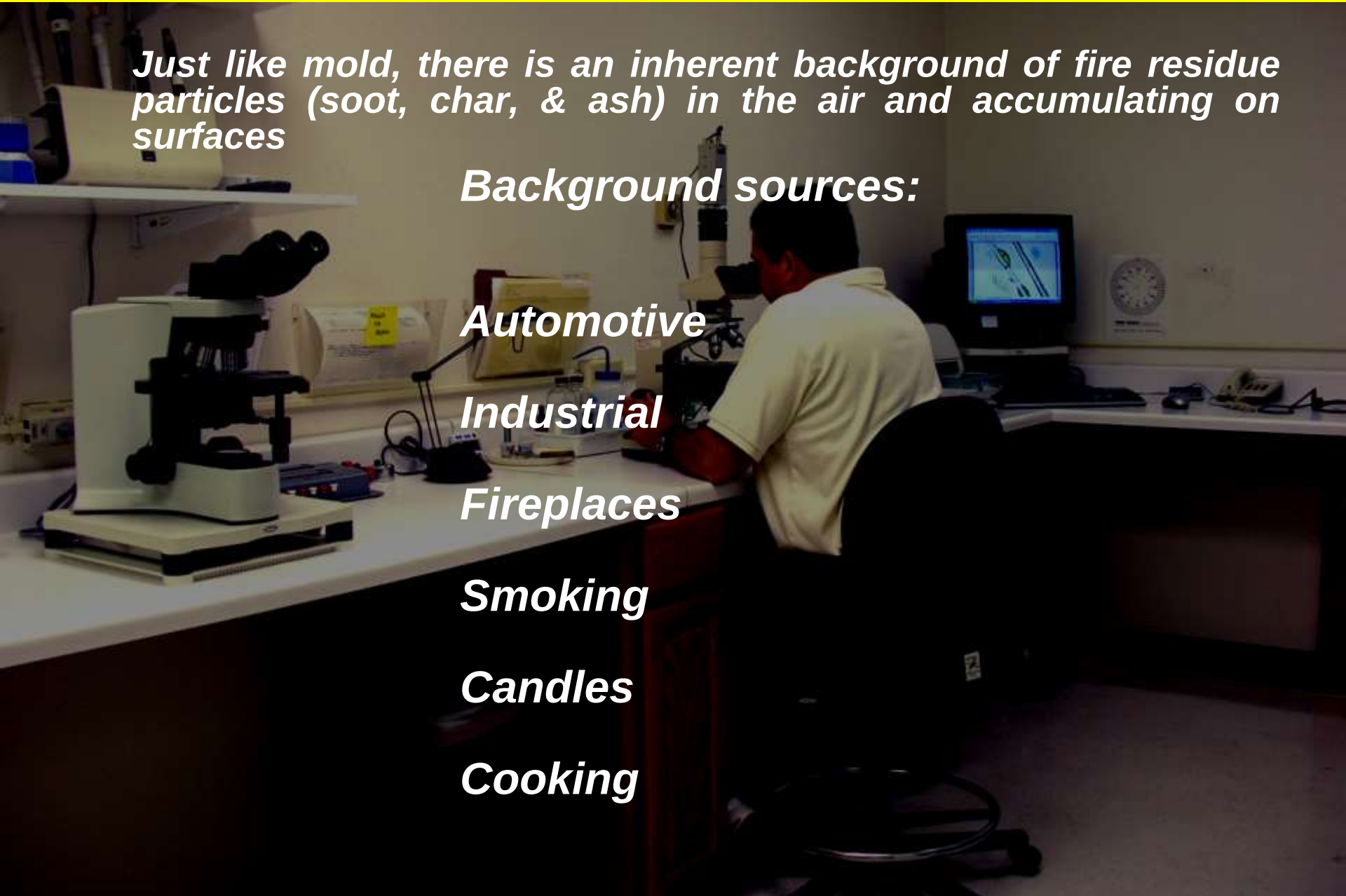








UNDERSTANDING THE BACKGROUND



Just like mold, there is an inherent background of fire residue particles (soot, char, & ash) in the air and accumulating on surfaces

Background sources:

Automotive

Industrial

Fireplaces

Smoking

Candles

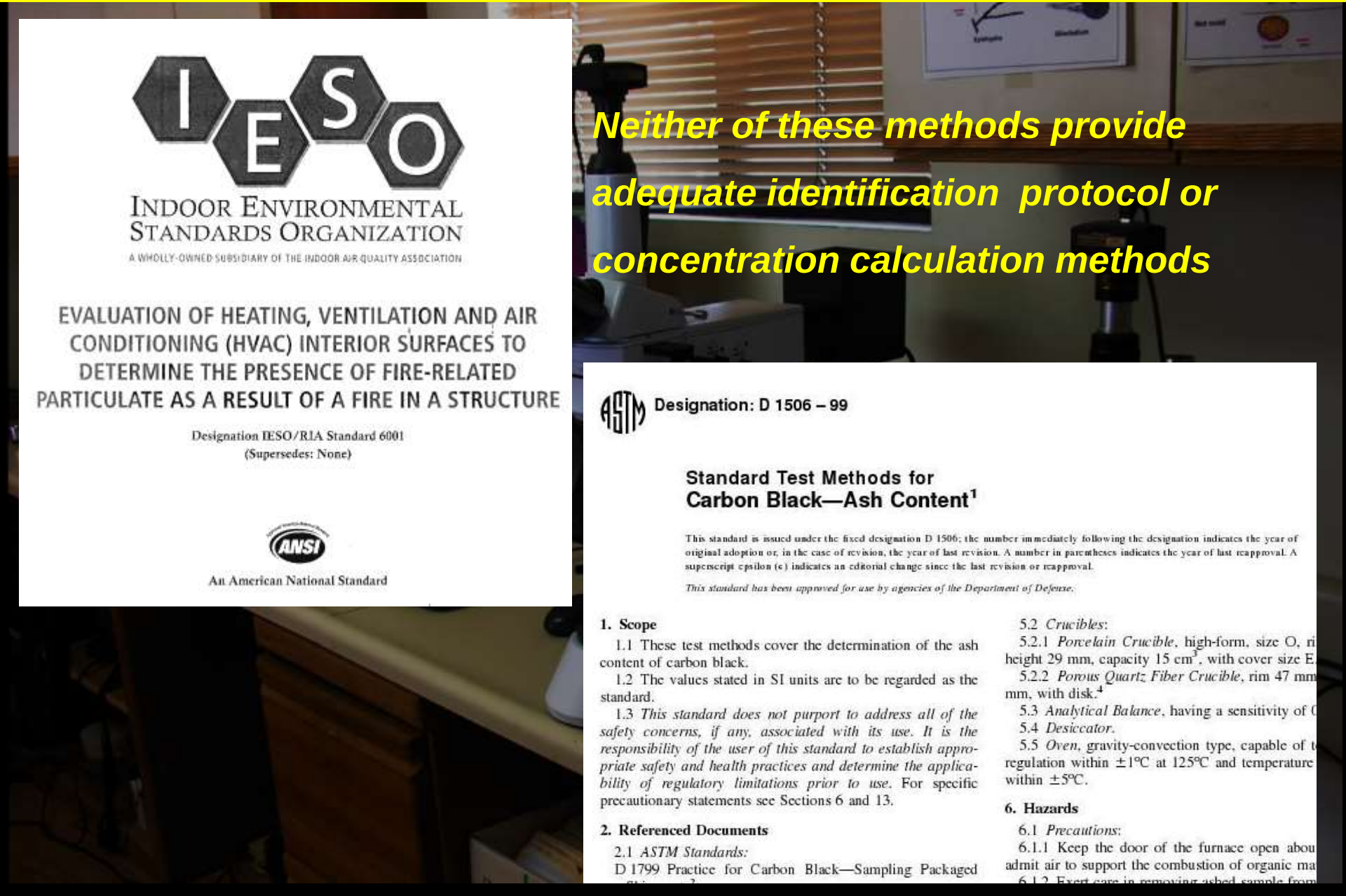
Cooking

SAMPLING METHOD RELIABILITY

	COLLECTION METHOD			
Quantitative Value	***Air***	***Tape***	***Bulk***	***Wipe***
Quantitative ratio %	*XXX*	*XXX*	*XX*	*X*
Surface concentration / area	*N/A*	*XXX*	*X*	*0*
"Soot &Char" integrity	*XXX*	*XXX*	*XX*	*X*
"Ash" integrity	*XX*	*XXX*	*XX*	*0*
Representative photos	*XXX*	*XXX*	*XX*	*XX*
pH Analysis	*0*	*X*	*XXX*	*X*

XXX = *Good / high*
XX = *Moderate*
X = *Limited under certain conditions*
0 = *Poor*

NO DEFINED MICROSCOPY METHODS EXIST



INDOOR ENVIRONMENTAL STANDARDS ORGANIZATION

A WHOLLY-OWNED SUBSIDIARY OF THE INDOOR AIR QUALITY ASSOCIATION

EVALUATION OF HEATING, VENTILATION AND AIR CONDITIONING (HVAC) INTERIOR SURFACES TO DETERMINE THE PRESENCE OF FIRE-RELATED PARTICULATE AS A RESULT OF A FIRE IN A STRUCTURE

Designation IESO/RIA Standard 6001
(Supersedes: None)

ANSI

An American National Standard

Neither of these methods provide adequate identification protocol or concentration calculation methods

Designation: D 1506 – 99

Standard Test Methods for Carbon Black—Ash Content[1]

This standard is issued under the fixed designation D 1506; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods cover the determination of the ash content of carbon black.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Sections 6 and 13.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1799 Practice for Carbon Black—Sampling Packaged

5.2 *Crucibles*:

5.2.1 *Porcelain Crucible*, high-form, size O, ri height 29 mm, capacity 15 cm^3, with cover size E

5.2.2 *Porous Quartz Fiber Crucible*, rim 47 mm mm, with disk.[4]

5.3 *Analytical Balance*, having a sensitivity of

5.4 *Desiccator*.

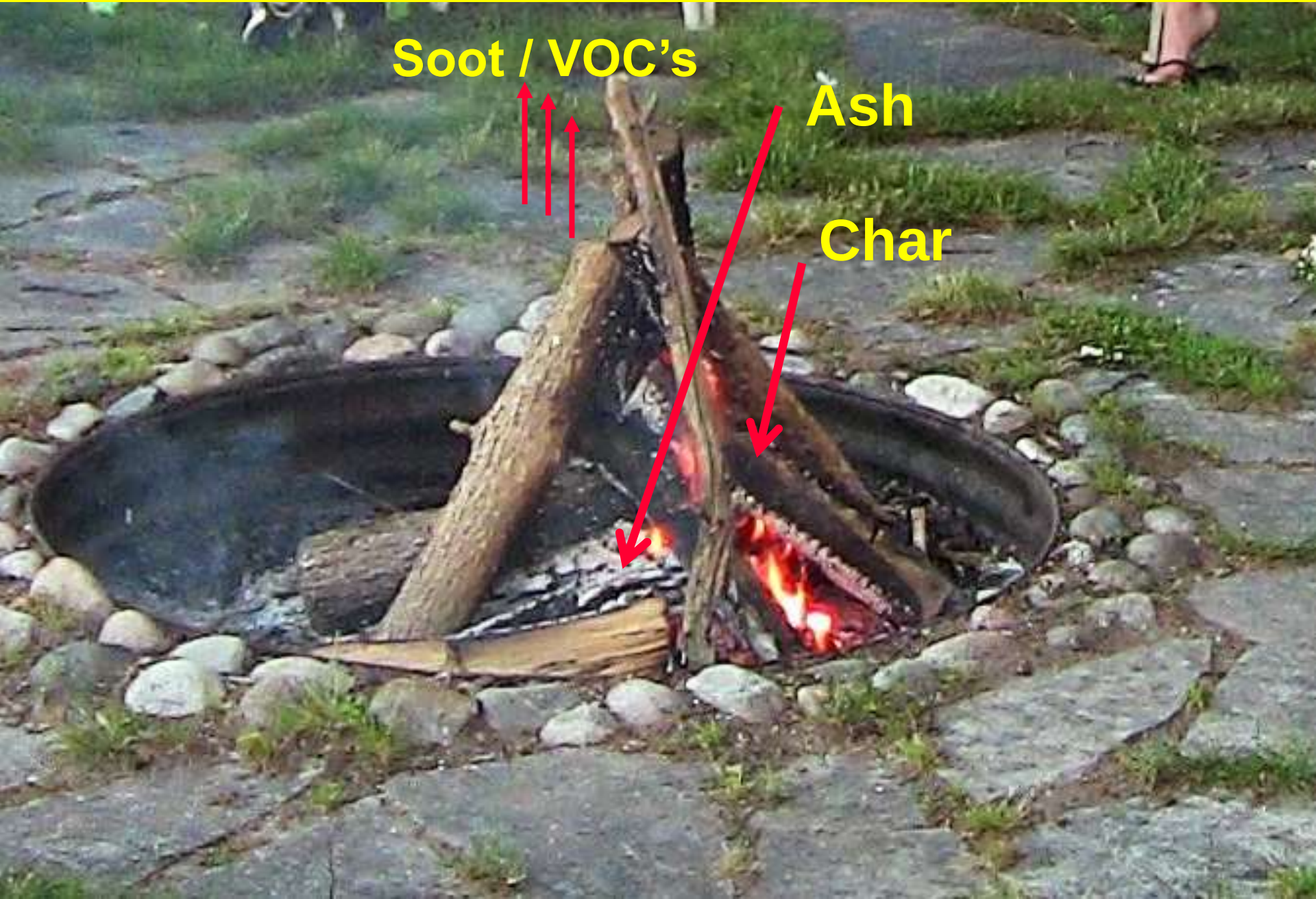
5.5 *Oven*, gravity-convection type, capable of t regulation within ±1°C at 125°C and temperature within ±5°C.

6. Hazards

6.1 *Precautions*:

6.1.1 Keep the door of the furnace open abou admit air to support the combustion of organic ma

COMPONENTS OF A FIRE



Analytical Microscopy Requirements

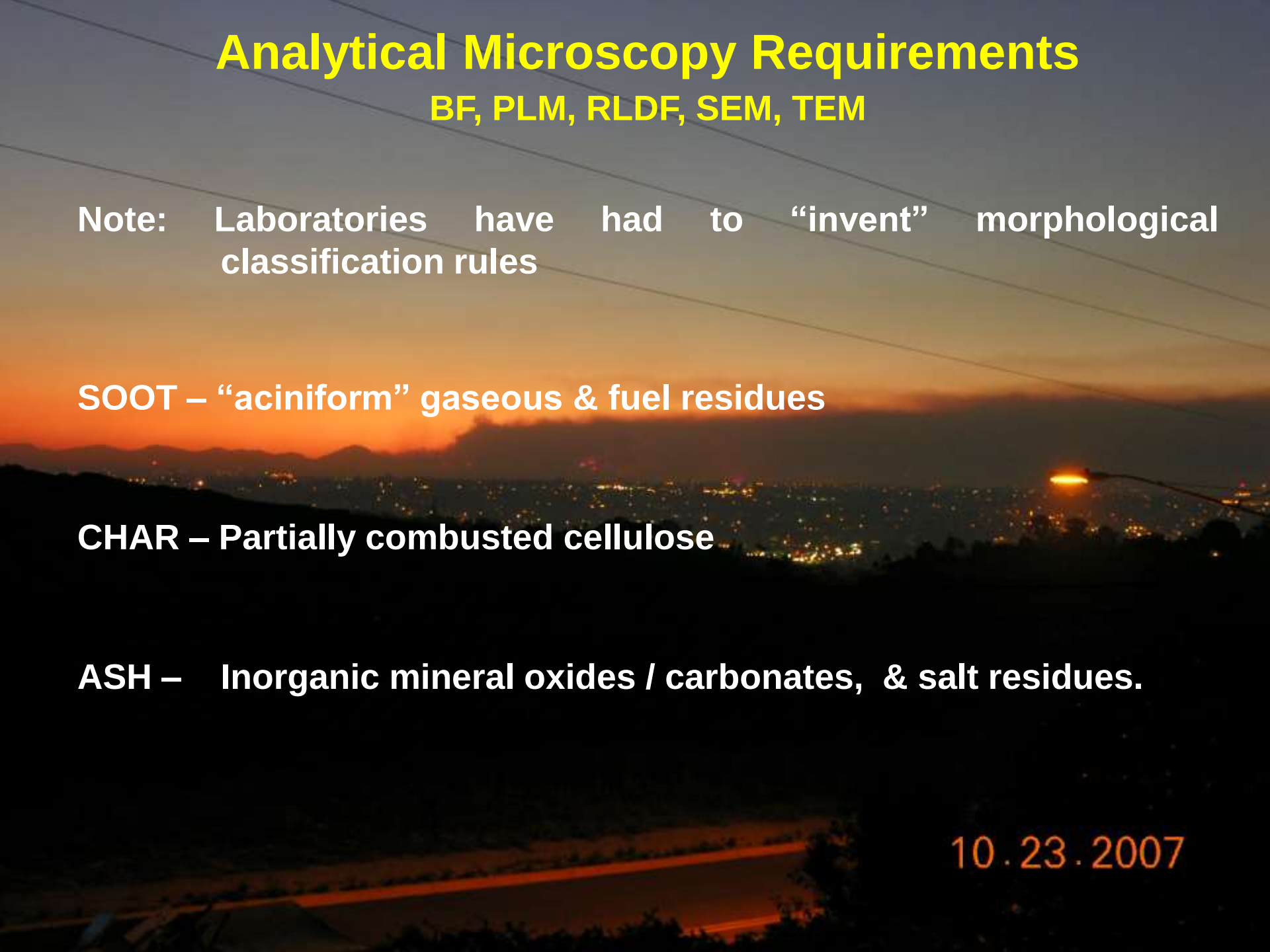
BF, PLM, RLDF, SEM, TEM

Note: Laboratories have had to "invent" morphological classification rules

SOOT – "aciniform" gaseous & fuel residues

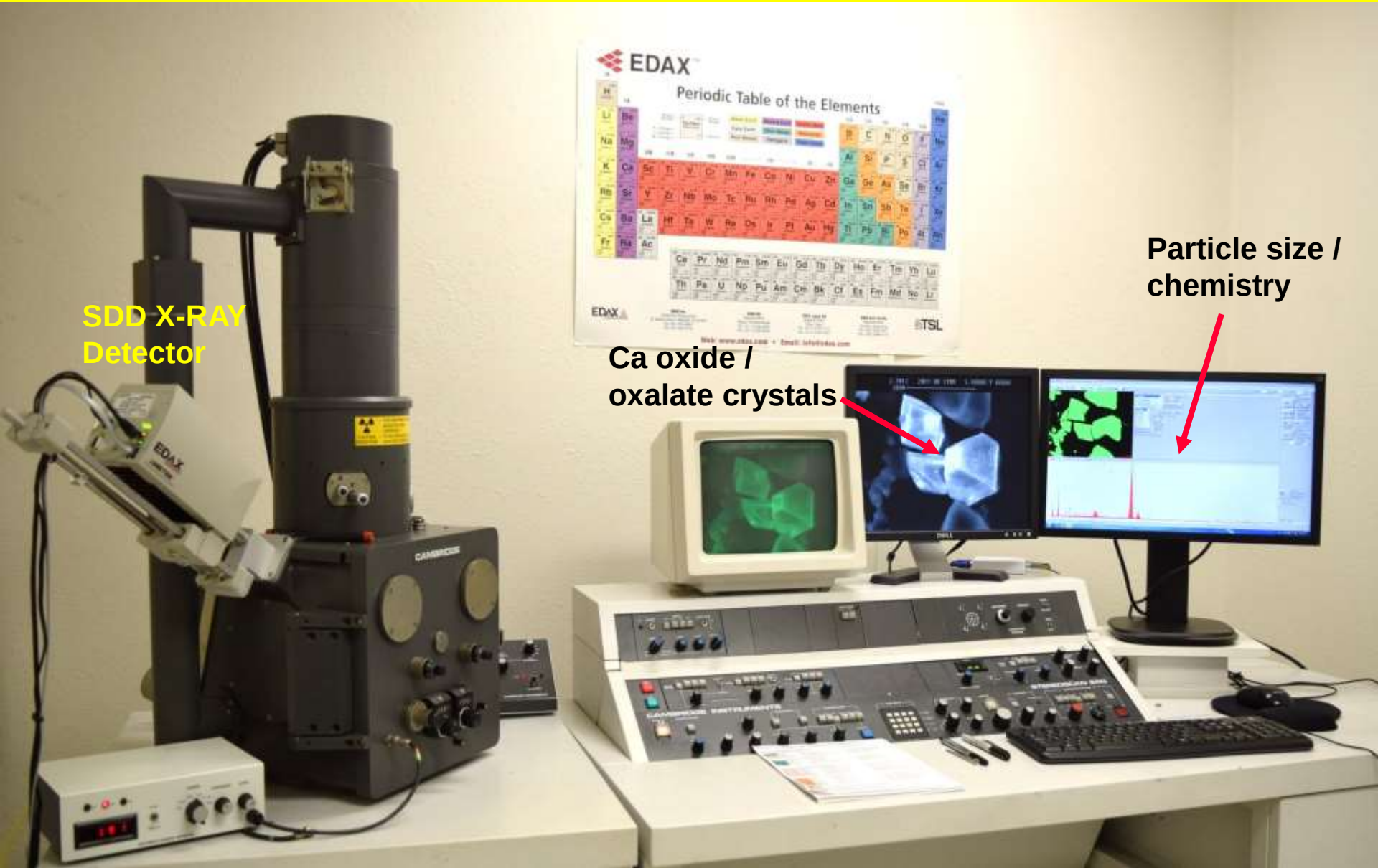
CHAR – Partially combusted cellulose

ASH – Inorganic mineral oxides / carbonates, & salt residues.

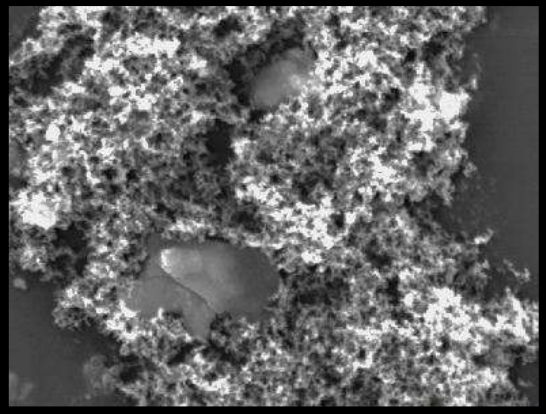
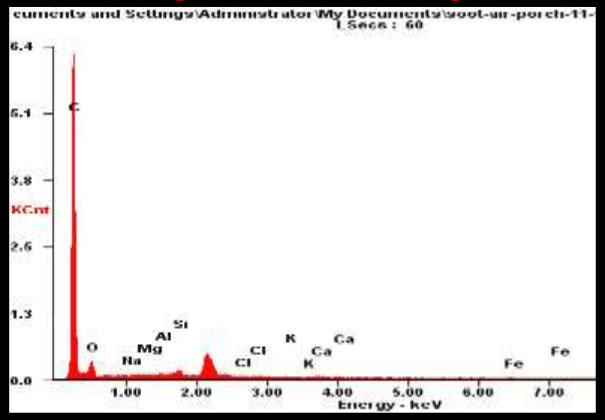
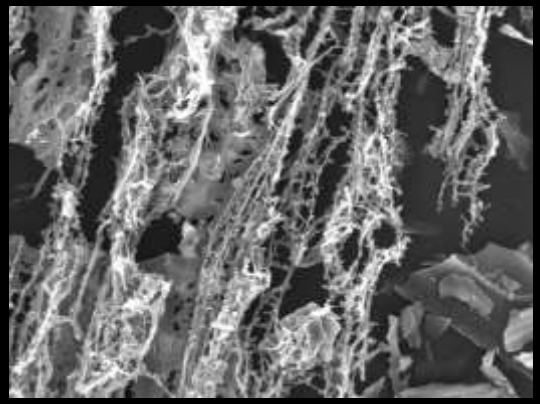
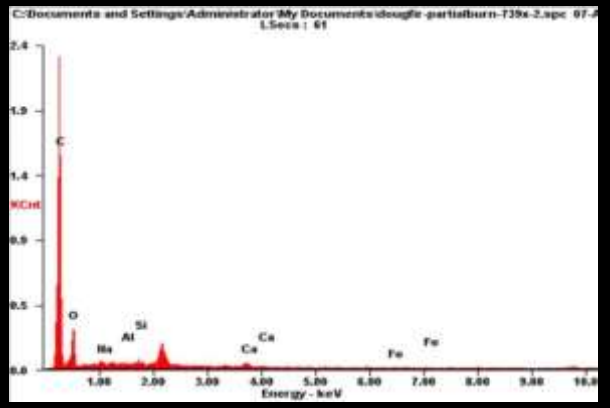
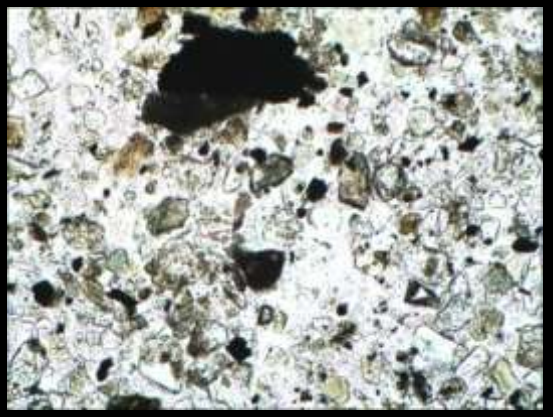
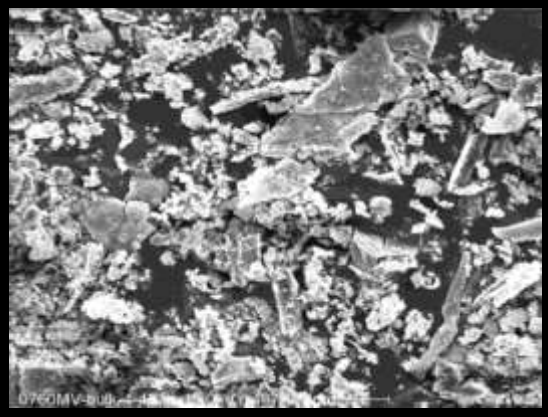
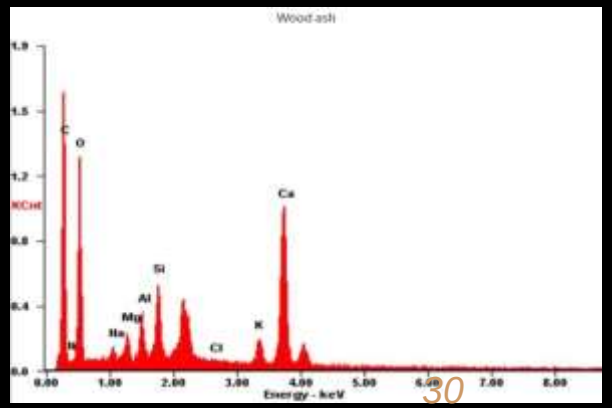


Polarized Light (PLM) Combined TL/RLDF/PLM Stereo RL low power

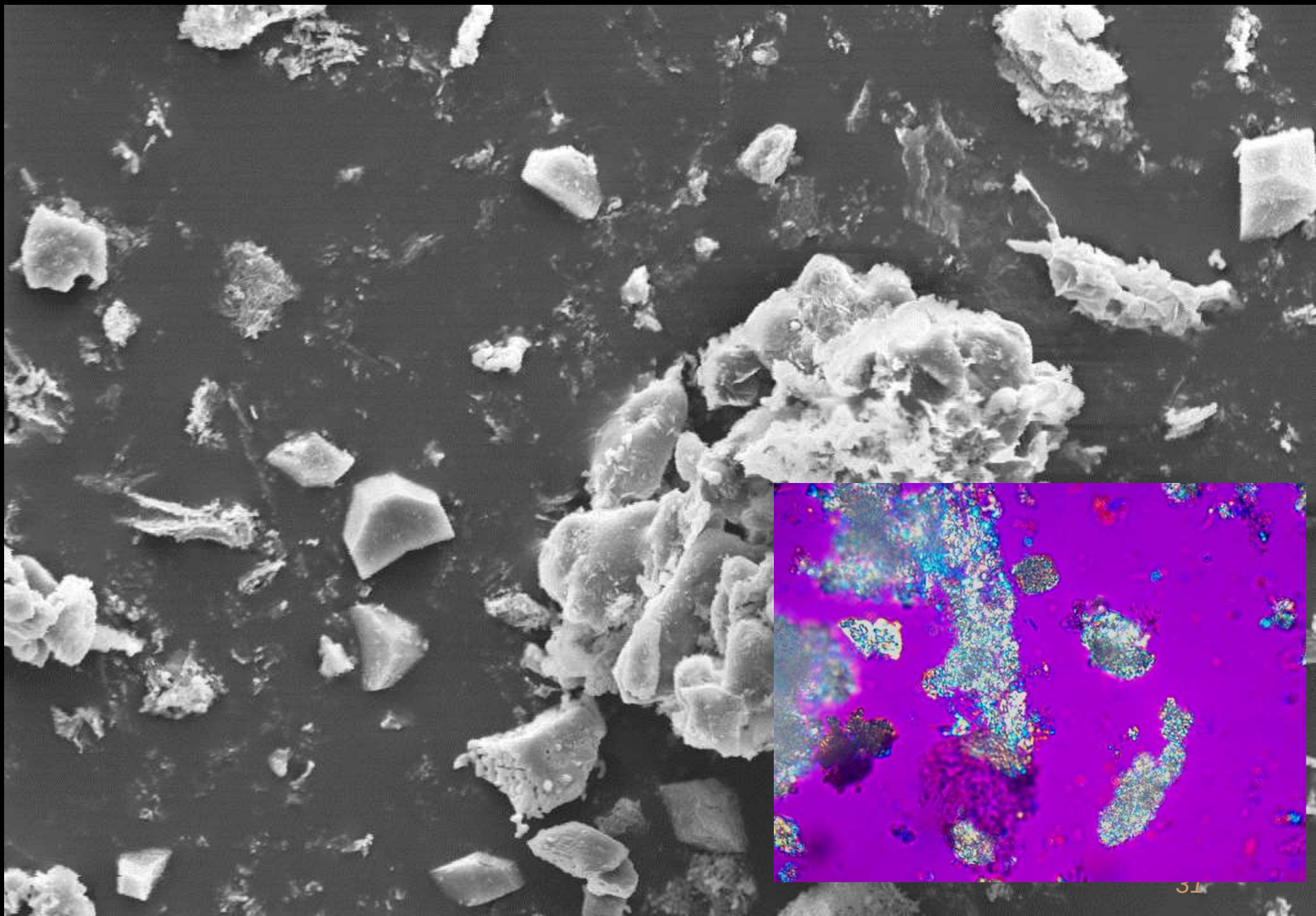
SCANNING ELECTRON MICROSCOPY & DISPERSIVE X-RAY



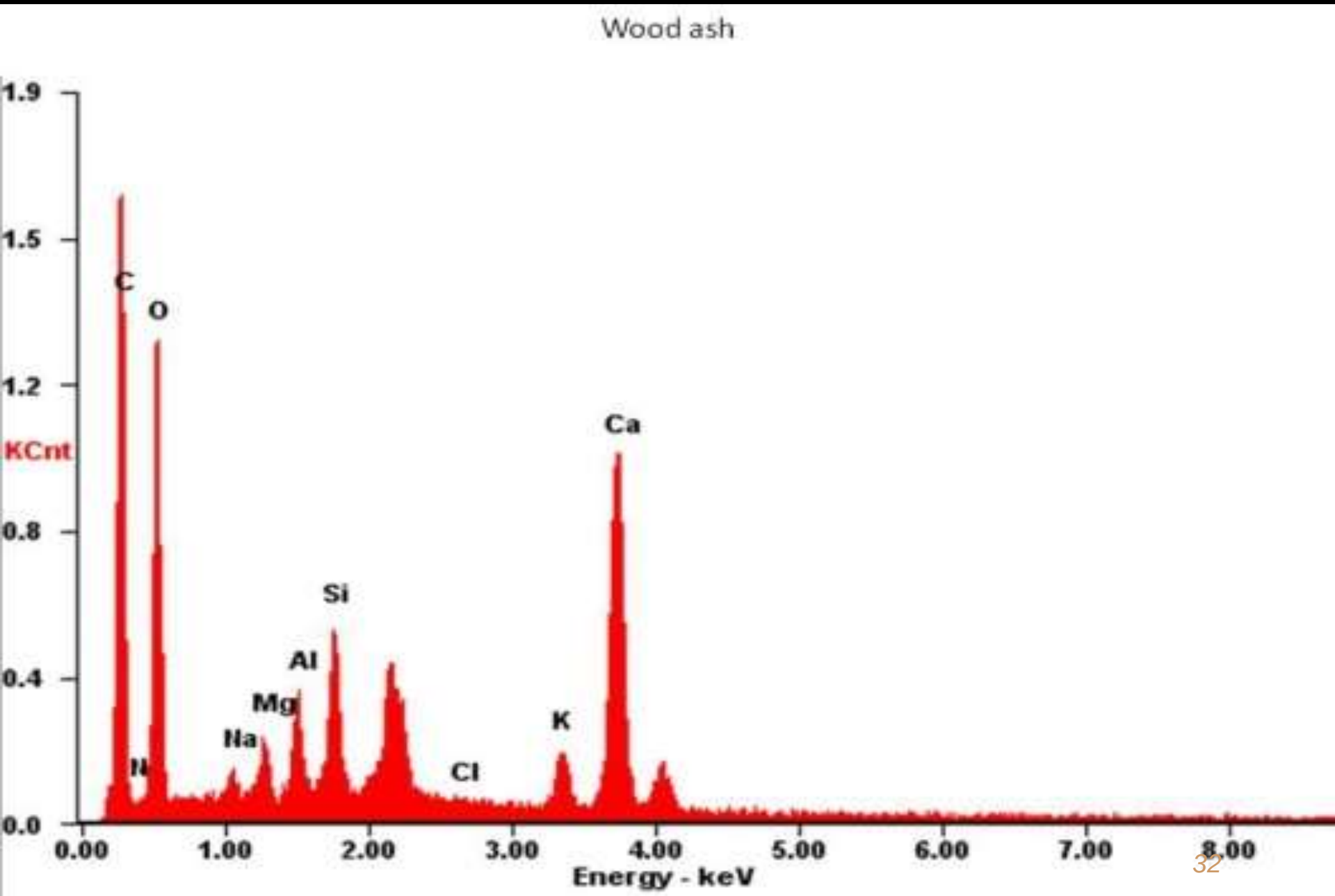
MORPHOLOGY OF FIRE RESIDUE PARTICLES

	Optical Microscopy	SEM	Dispersive X-ray
Soot			
Char			
Ash			

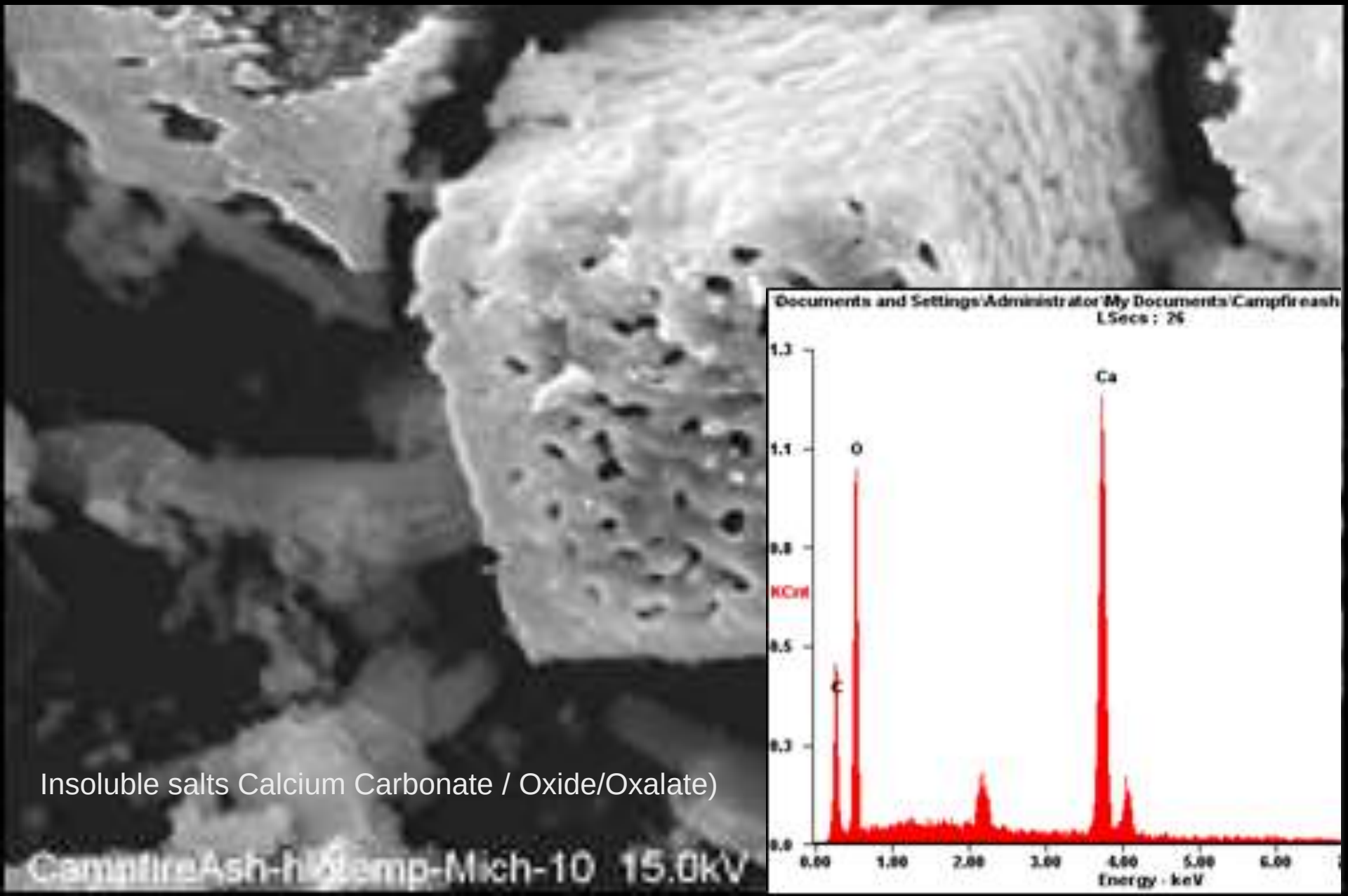
ASH – PLM / SEM



TRANSITIONAL CHAR / ASH – X-RAY



ASH - COMPONENTS



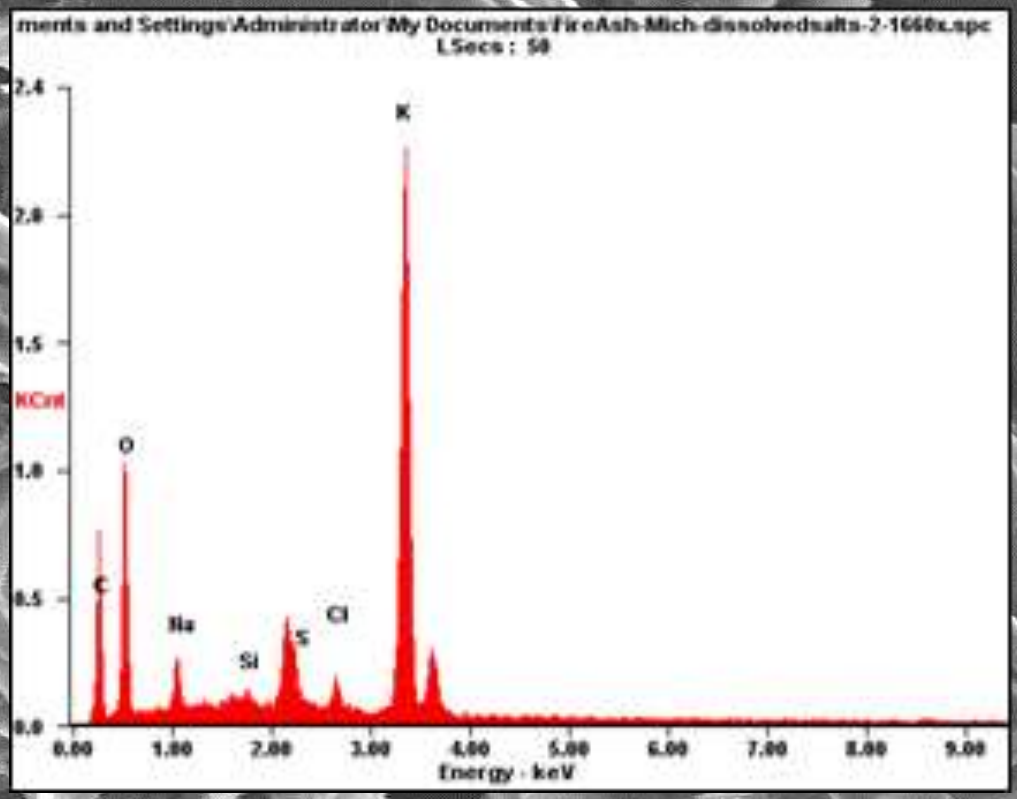
Insoluble salts Calcium Carbonate / Oxide/Oxalate)

ASH - COMPONENTS

ASH - COMPONENTS

SOLUBLE PHASE

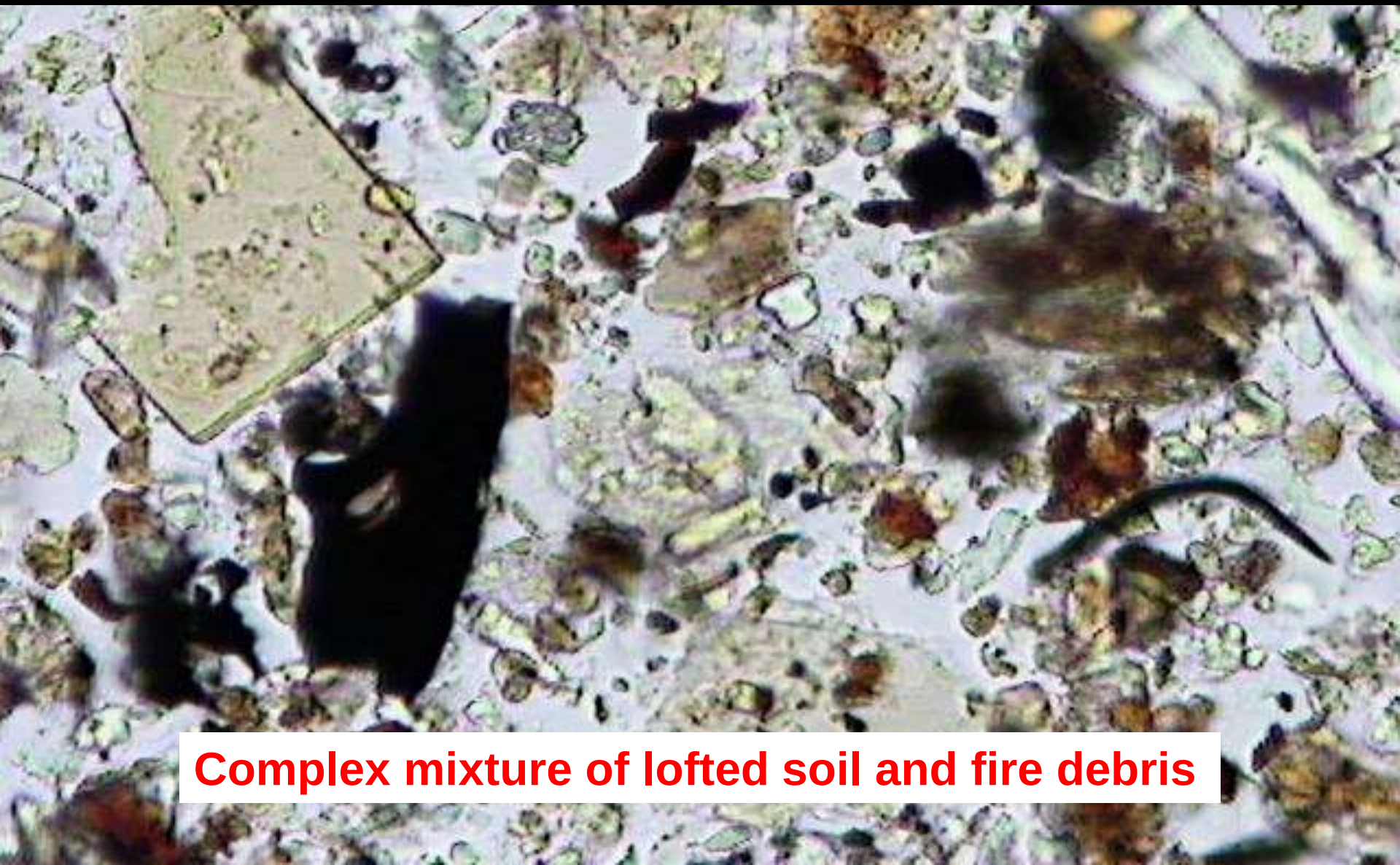
Primarily KOH - (Responsible for corrosive pH)



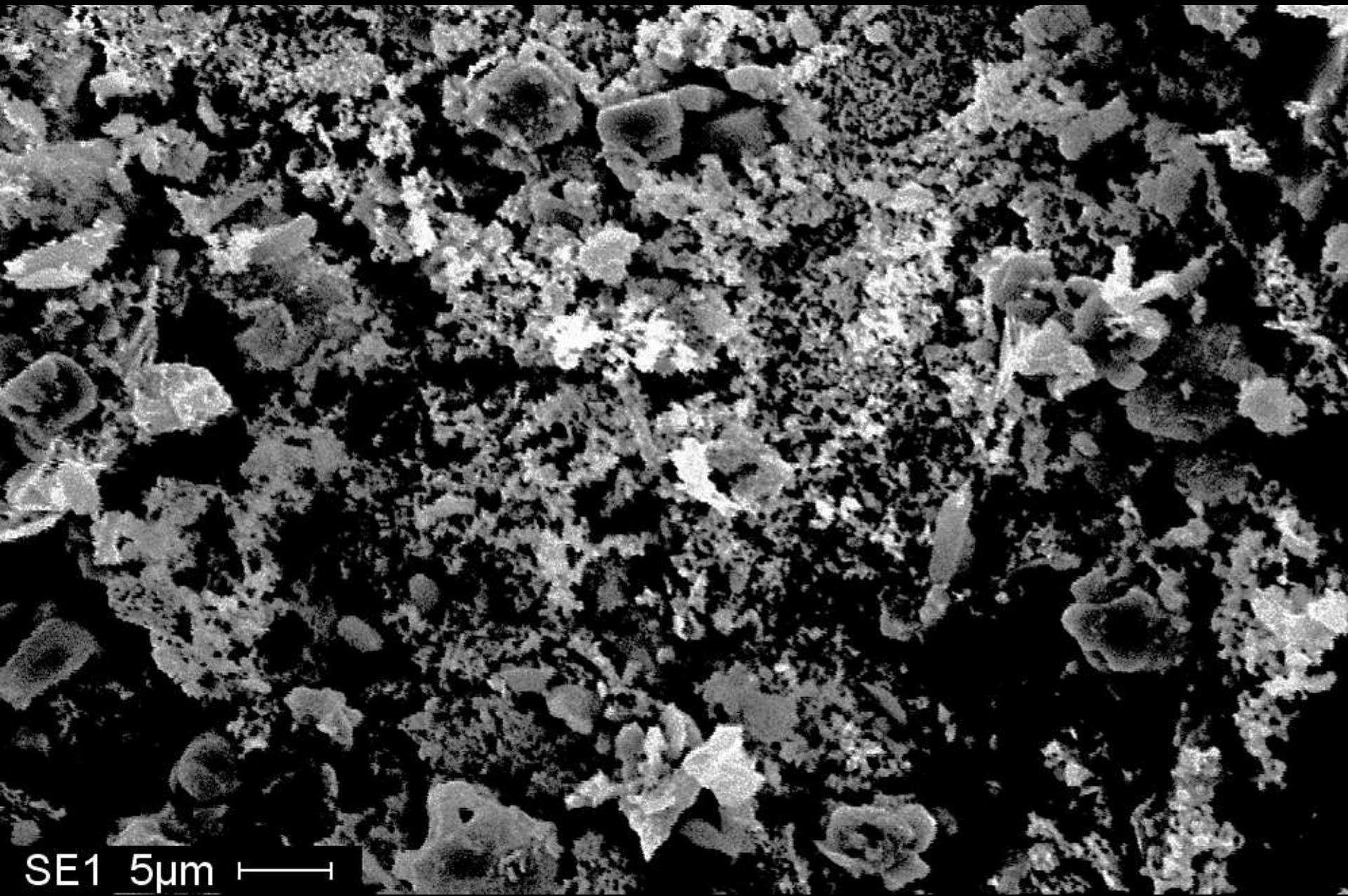
FireAsh-Mich-dissolved-2 15.0kV x1660 5µm

“FIRESTORM” AIR SAMPLE– 10 / 23/ 07

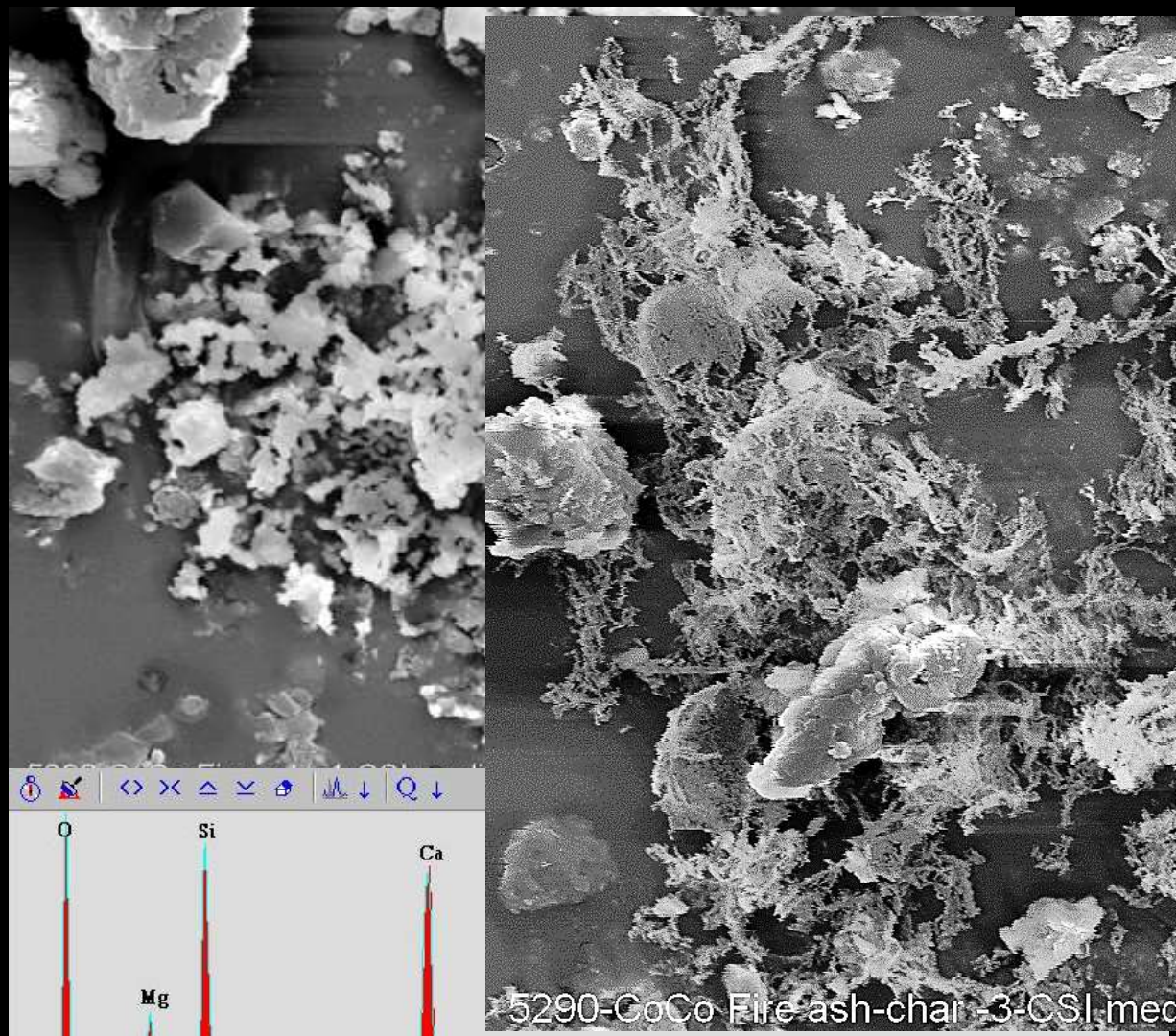
Pacific Beach



SEM AIR SAMPLE – 10 / 23/ 07



COCO Fire Airborne Ash – 5/21/14



POSSIBLE MICROSCOPIC QUANTIFICATION PROCEDURES

Bulk & Tape Lift samples –

Numerical % - ***Numerical ratio of fire residue particles to "non-fire" residue particles***

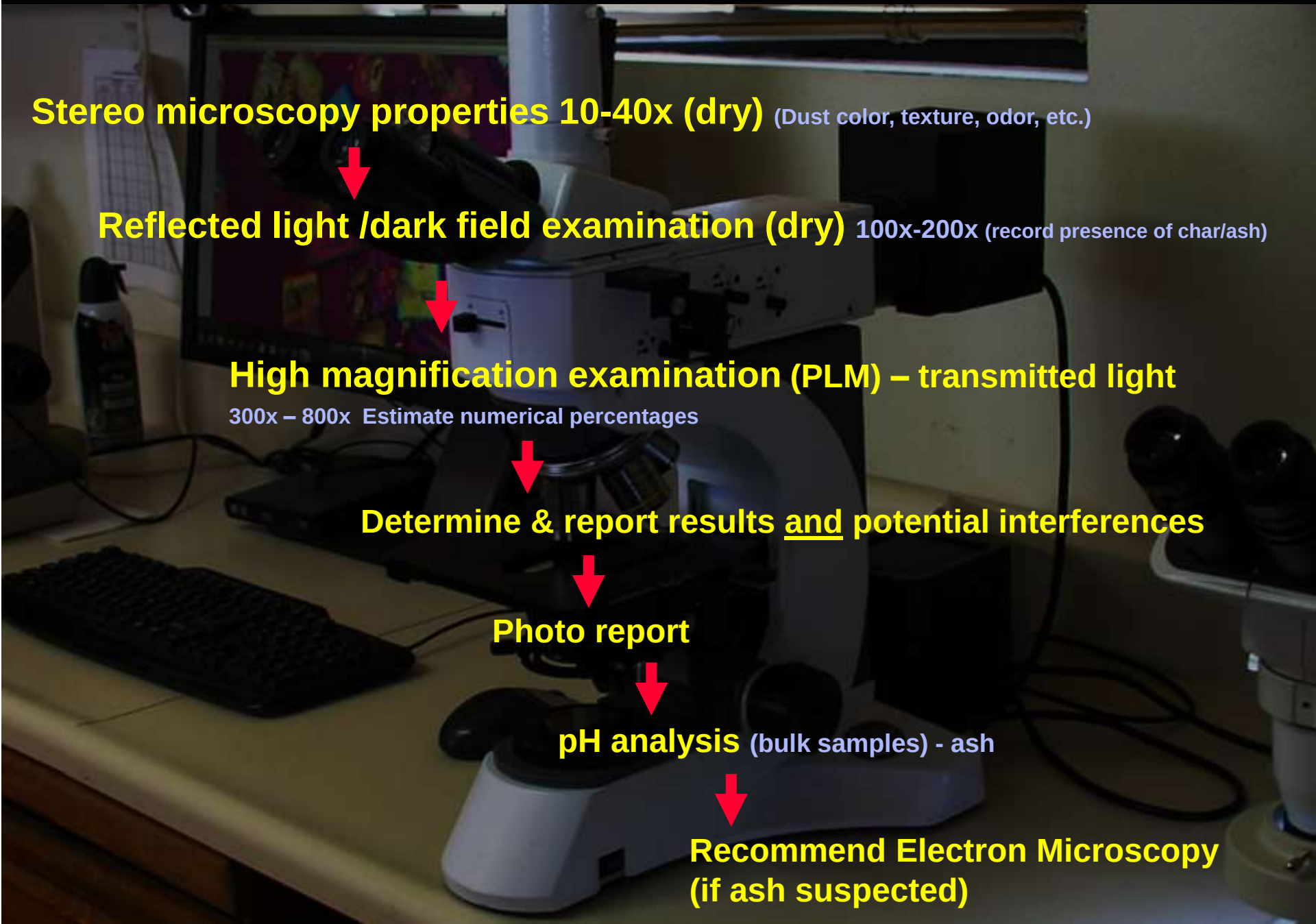
Estimated area % - ***Visual X-section area comparison – "An eyeball estimate"***

Point Counting - ***Numerical estimation of area based on the number of "points" under a grid overlay.***

Air samples –

Particles / m^3 air – ***Concentration / air volume***

ANALYSIS FLOW DIAGRAM



Stereo microscopy properties 10-40x (dry) (Dust color, texture, odor, etc.)

↓

Reflected light /dark field examination (dry) 100x-200x (record presence of char/ash)

↓

High magnification examination (PLM) – transmitted light

300x – 800x Estimate numerical percentages

↓

Determine & report results and potential interferences

↓

Photo report

↓

pH analysis (bulk samples) - ash

↓

Recommend Electron Microscopy (if ash suspected)

SUGGESTED MICROSCOPY REPORT FORMAT

Environmental Analysis Associates, Inc. • 5290 Soledad Road • San Diego, CA 92109 • (858) 272-7747

DUST / FIRE RESIDUE CONSTITUENT ANALYSIS SUMMARY - Optical Microscopy

Client Name : ABC Environmental
Client Project # : 14-00123
Project Description : 123 Elm Street
Client Sample # : 123-01
Client sample description: Master bedroom vanity
EAA Project # : 14-01234
EAA Sample # : 1234-01
Sample Date : 4/20/14
Sample media: tape lift

Comments : Moderate fire residue present

Concentrations may be higher than reported due to interferences

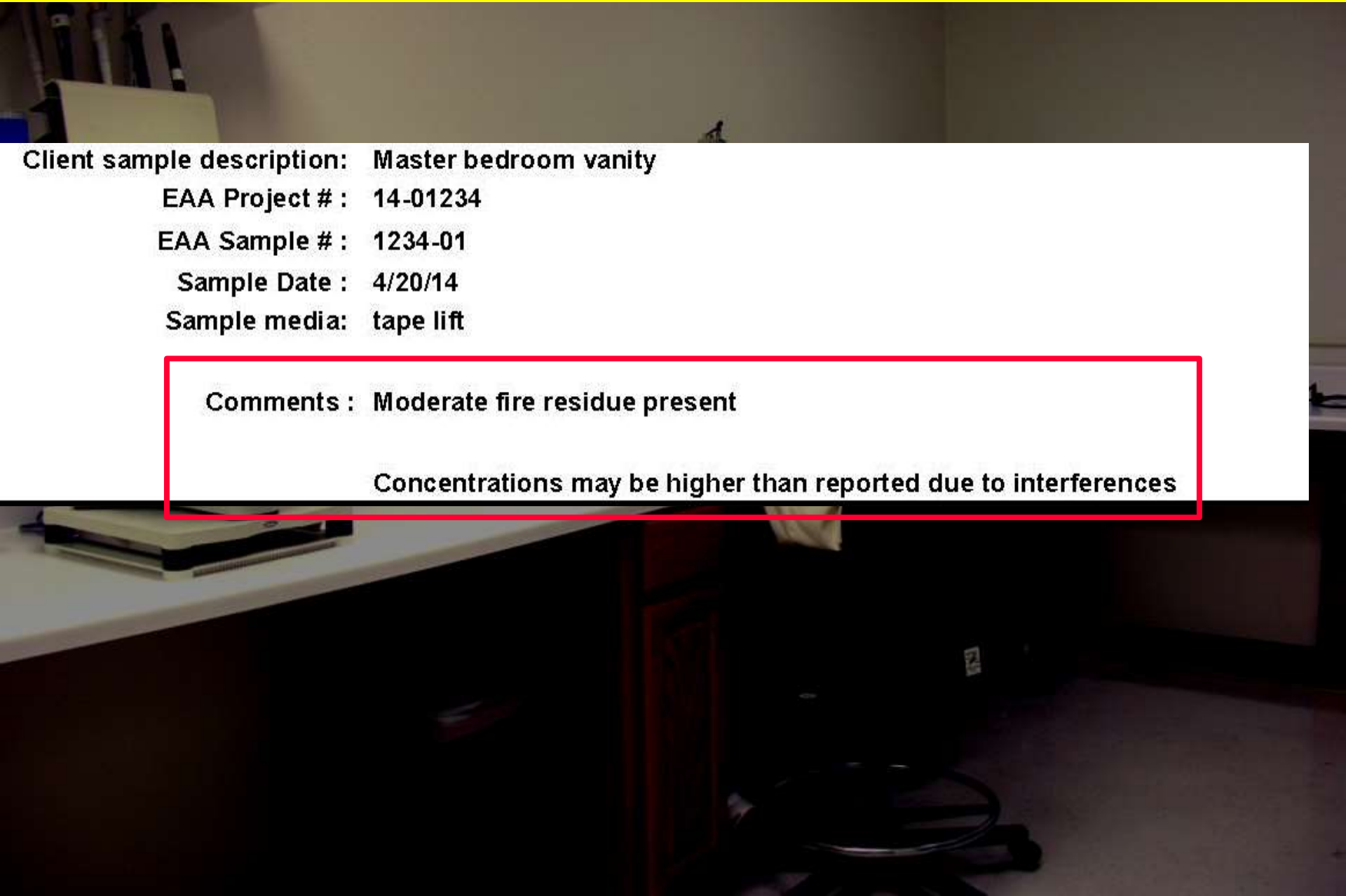
	QUALITATIVE LAB OBSERVATIONS	Potential fire residue indicators
Lab sample description	Fine off-white powdery dust with black fragments	
Is a smoke or fire residue odor observed ?		No
Are char particles visible in low power (10-50x) stereo microscopy?		Yes - large 20-50um
Are ash-like particles visible in low power (10-50x) stereo microscopy?		No
	INORGANIC/COMPOSITE CONSTITUENTS	
		Estimated Numerical %
Fibrous Constituents :	Cellulose/Synthetics	1.2
	Fiberglass/Mineral wool	0.2
Non-fibrous Constituents :	Inorganic mineral dust / soil	59.5
	Other opaque debris	10.7
	FIRE RESIDUE CONSTITUENTS	**TOTAL %**
		13.1
Combustion-like Constituents :	Aciniform / soot-like fine particles	1.9
	Ash -like mineral residue particles	0.5
	Char (Pyrolized plant material)	10.7
	MICRO-BIOLOGICAL CONSTITUENTS	
		Estimated Numerical %
Mold Spores / Structures :	Cladosporium	0.5
Pollen :	Unspecified	not detected
Plant fragments :	Flower parts, trichomes, etc.	0.2
Animal fragments :	Dander / skin cells	13.1
Miscellaneous :	Insect parts	0.2
	ORGANIC / OTHER CONSTITUENTS	
		Estimated Numerical %
Biogenic / organic debris :	Opaque biogenic debris	1.2

Comments:

Total particles counted (>3.0µm) : 420
Detection Limit (%) : 0.24

Analyst : Daniel M. Baxter **Date :** 4/25/14

SUGGESTED MICROSCOPY REPORT FORMAT



Client sample description:	Master bedroom vanity
EAA Project # :	14-01234
EAA Sample # :	1234-01
Sample Date :	4/20/14
Sample media:	tape lift

Comments : Moderate fire residue present

Concentrations may be higher than reported due to interferences

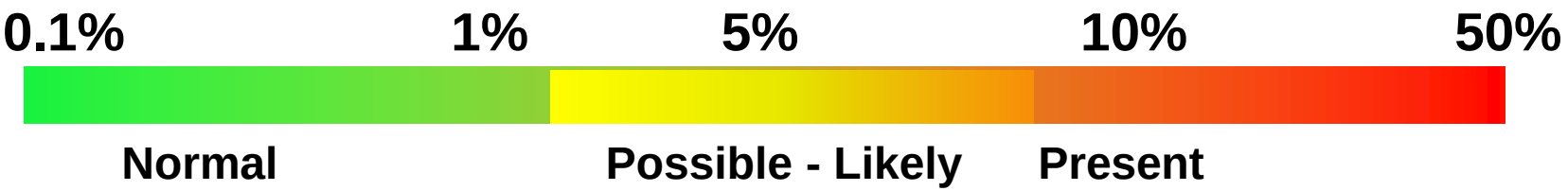
SUGGESTED MICROSCOPY REPORT FORMAT

Qualitative parameters – Quantitative - Interferences

ple description	Fine off-white powdery dust with black fragments	
ke or fire residue odor observed ?		No
particles visible in low power (10-50x) stereo microscopy?		Yes - large 20-50um
like particles visible in low power (10-50x) stereo microscopy?		No
	INORGANIC/COMPOSITE CONSTITUENTS	
		Estimated Numerical %
Fibrous Constituents :	Cellulose/Synthetics	1.2
	Fiberglass/Mineral wool	0.2
Non-fibrous Constituents :	Inorganic mineral dust / soil	59.5
	Other opaque debris	10.7
	FIRE RESIDUE CONSTITUENTS	**TOTAL %**
		13.1
Combustion-like Constituents :	Aciniform / soot-like fine particles	1.9
	Ash -like mineral residue particles	0.5
	Char (Pyrolized plant material)	10.7

SUGGESTED CONTAMINATION GUIDANCE – MICROSCOPY %

Optical Microscopy - % Totals of char, ash, & soot-like debris



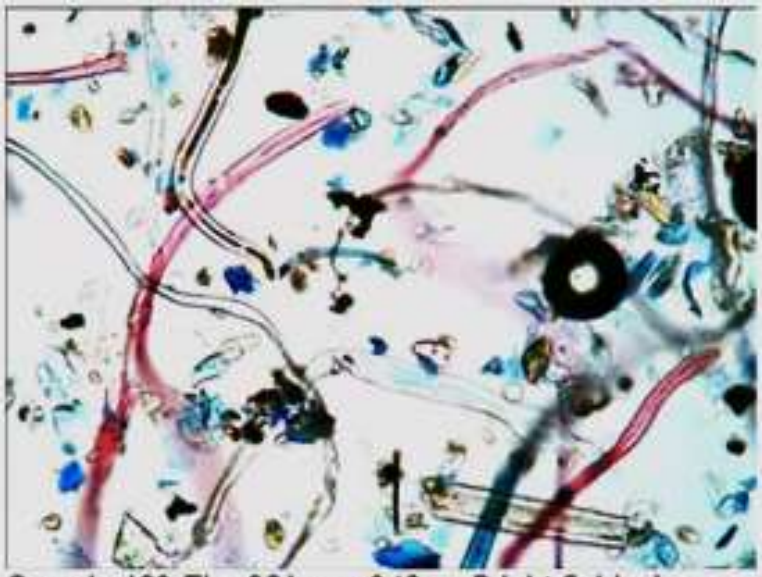
<1%	"Typical" or normal background
1-5%	Contamination unlikely but possible
5-10%	Contamination is possible to likely.
>10%	Contamination present

Surface fire residue particles - "numerical ratio or area measurements" cannot be directly used as a measure of "damage".

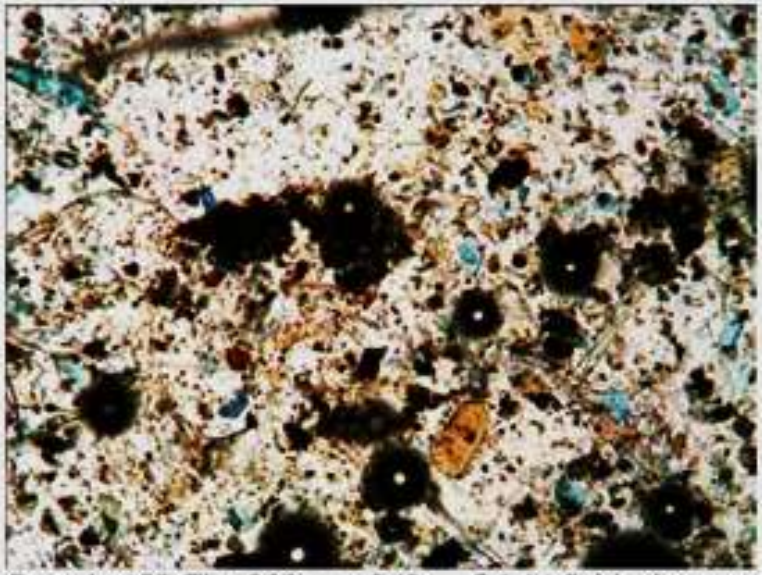
REMEMBER – The laboratory variability of this type of data is 1% +- 3%

THE PHOTOGRAPHIC REPORT

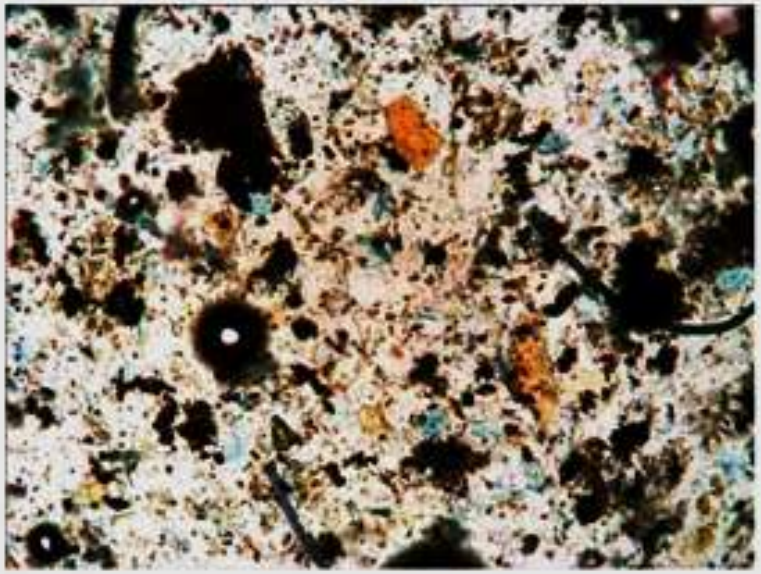
Photos provide critical qualitative information



Sample 123 Elm-001 – ~340x. Bright field microscopy

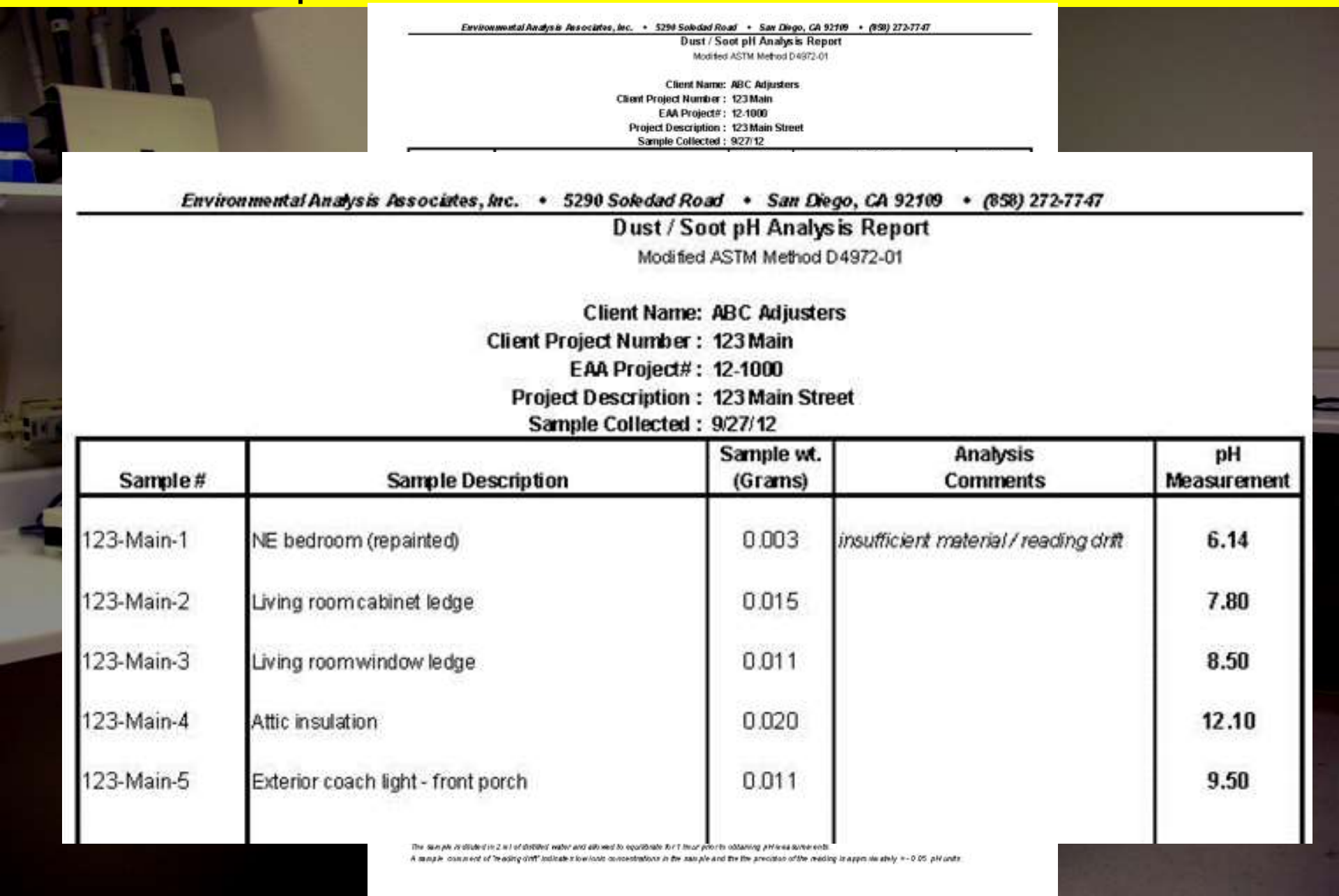


Sample 123 Elm-002 – ~340x. Bright field microscopy



THE pH REPORT

pH ANALYSIS OF BULK MICRO-VAC DUST SAMPLES



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Dust / Soot pH Analysis Report

Modified ASTM Method D4972-01

Client Name: ABC Adjusters
Client Project Number : 123 Main
EAA Project# : 12-1000
Project Description : 123 Main Street
Sample Collected : 9/27/12

Sample #	Sample Description	Sample wt. (Grams)	Analysis Comments	pH Measurement
123-Main-1	NE bedroom (repainted)	0.003	*insufficient material / reading drift*	**6.14**
123-Main-2	Living room cabinet ledge	0.015		**7.80**
123-Main-3	Living room window ledge	0.011		**8.50**
123-Main-4	Attic insulation	0.020		**12.10**
123-Main-5	Exterior coach light - front porch	0.011		**9.50**

The sample is diluted in 2 ml of distilled water and allowed to equilibrate for 1 hour prior to obtaining pH measurements.
A sample comment of "reading drift" indicates low ionic concentrations in the sample and the the precision of the reading is approximately +- 0.05 pH units.

pH ANALYSIS

pH ANALYSIS OF BULK DUST SAMPLES (Modified ASTM D4972-01)

pH analysis is a good surrogate analysis for the potential presence of caustic settled "ash" particles from wildfires.

Normal indoor background dust pH levels range from 6-8.

Seawater has a pH of 8.3.

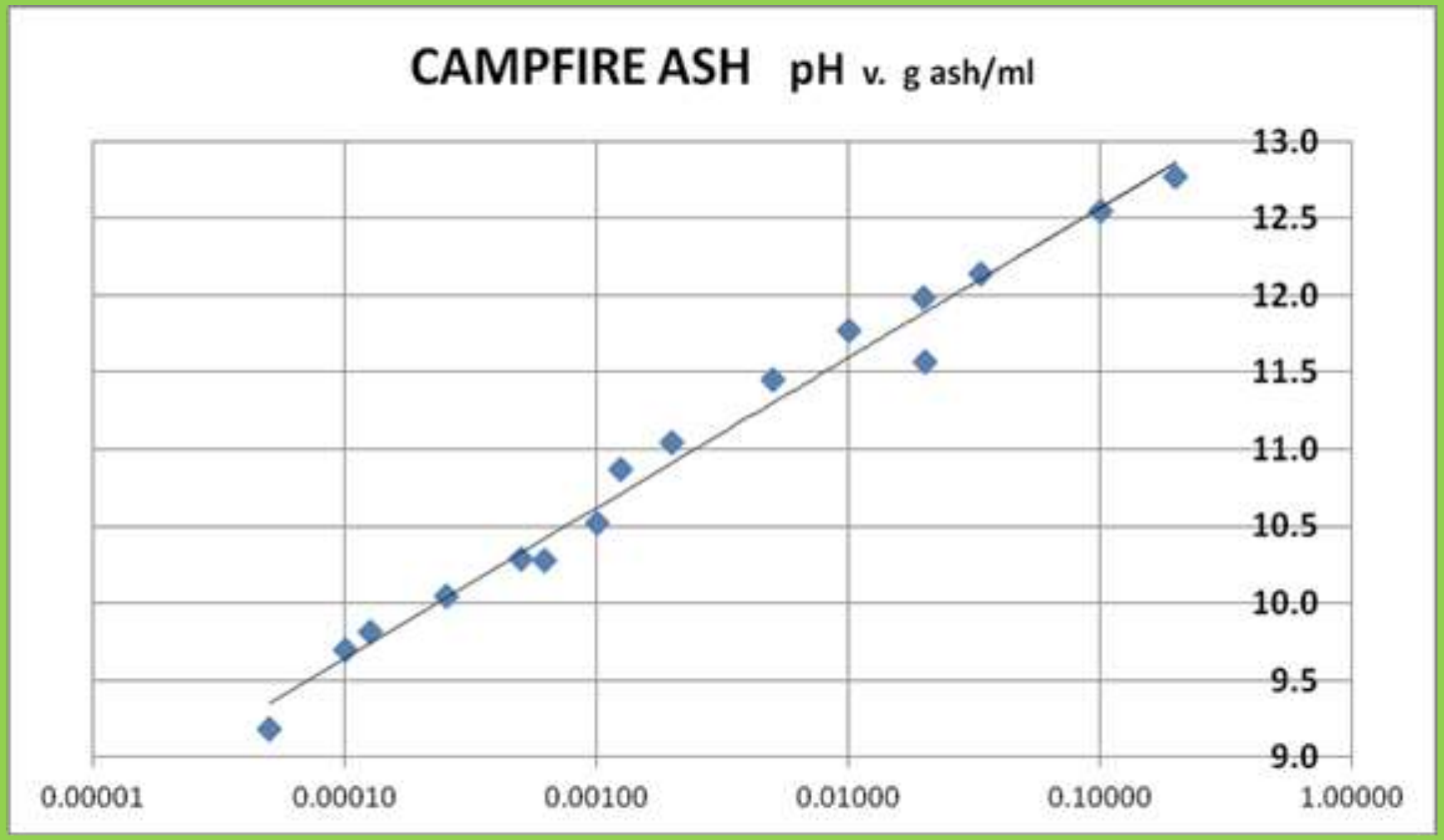
pH measurements from > 8.5 (in the absence of other chemicals) are a possible indicator of the presence of fire ash.

pH measurements above 9.0 (in the absence of other chemicals) are a likely indicator of fire ash infiltration.

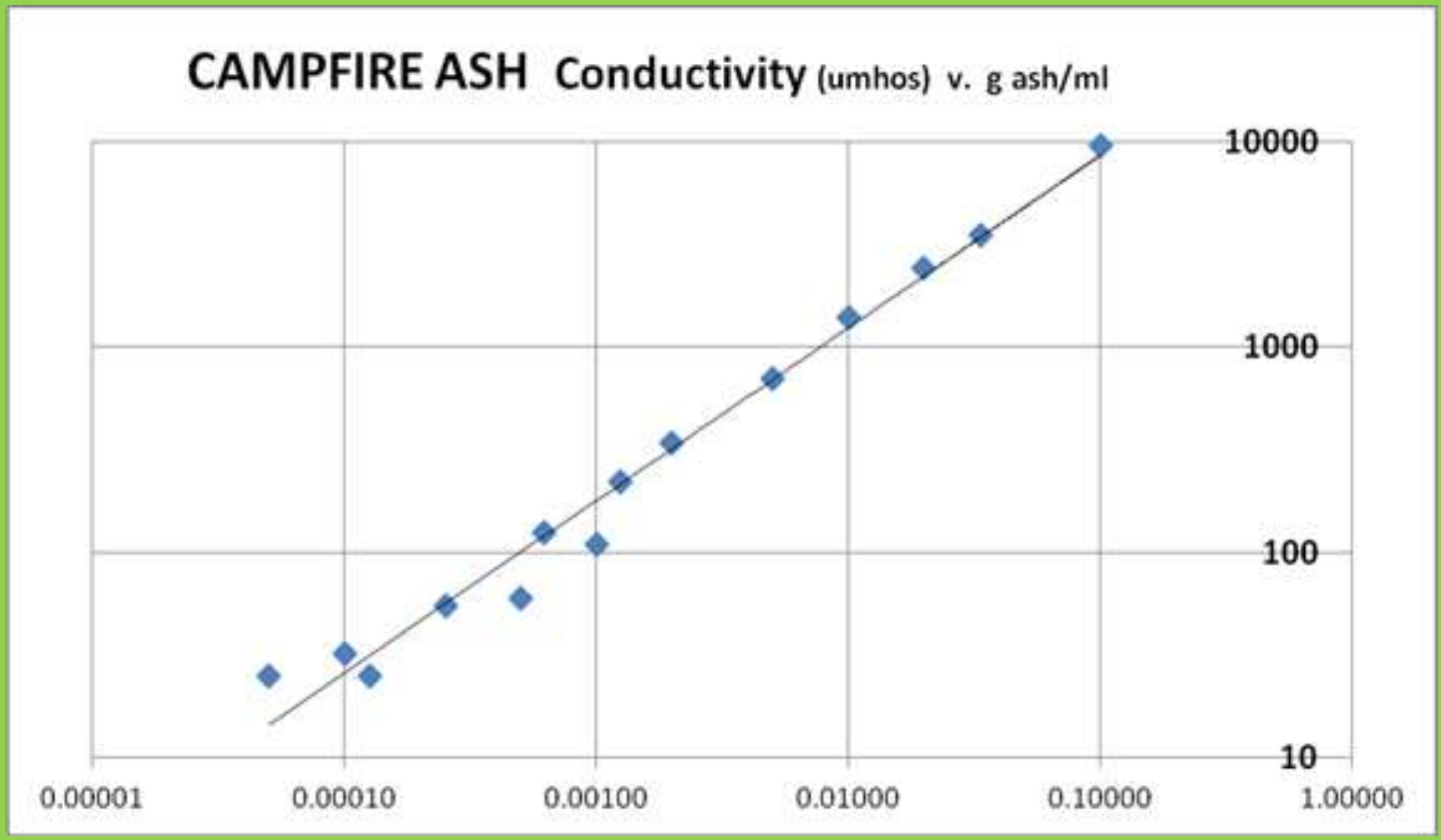
We can only use pH "ranges" because the amount of dust used in the analysis is always subject to a limited amount of provided sample.

pH ANALYSIS METHOD – EAA

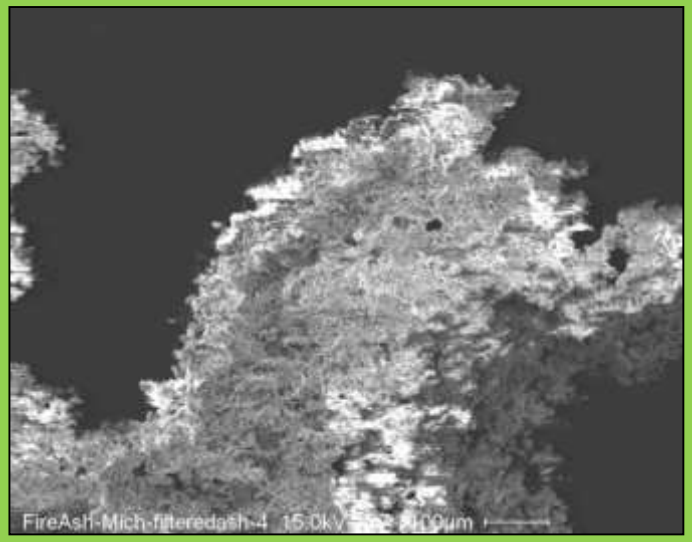
pH v. g/ml -- Serial dilution

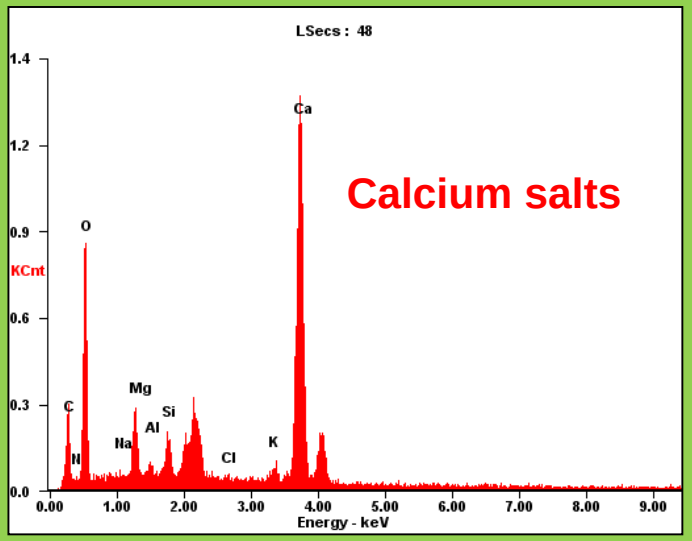


CONDUCTIVITY ANALYSIS - EAA

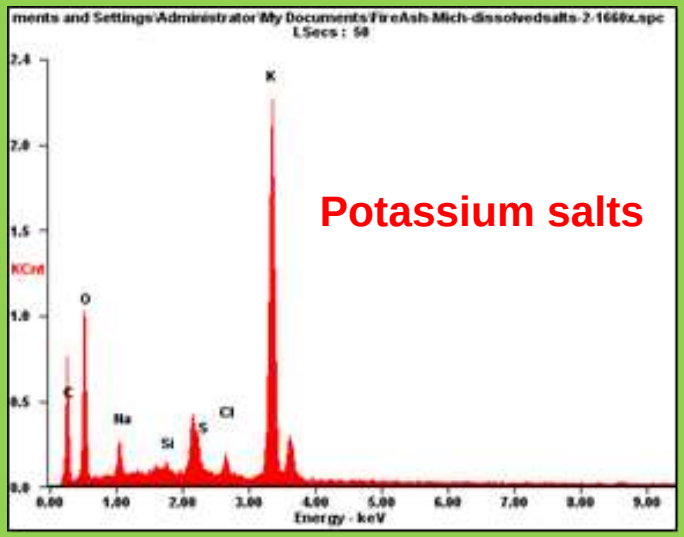


SOLUBLE vs. NON-SOLUBLE ASH COMPONENTS





X-ray Composition of the Fire Ash Filtrate **"Solids"** After a Triple Rinse of Distilled Water



X-ray Composition of the Fire Ash Supernate Solution Crystals After Evaporation

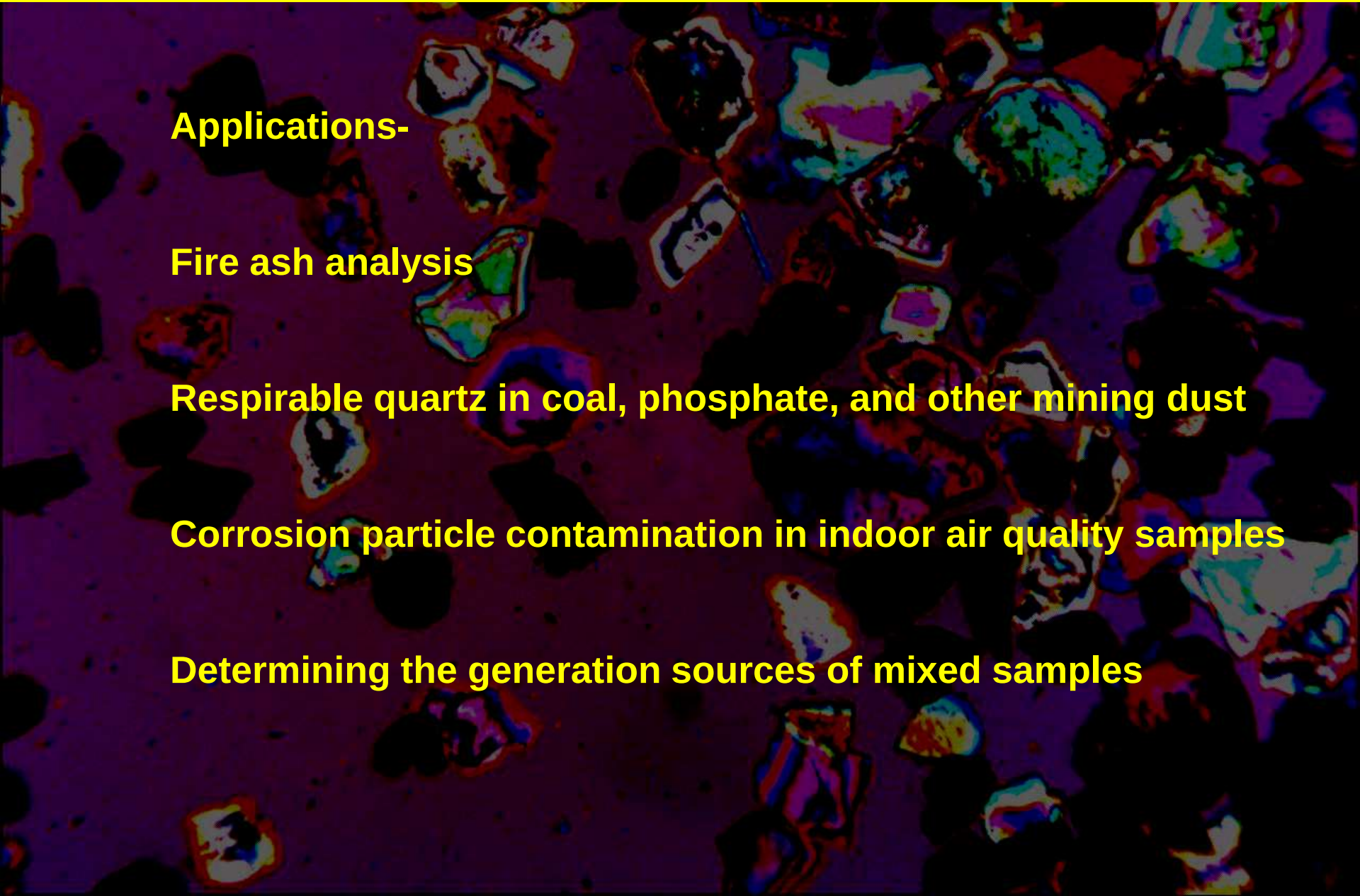
pH ANALYSIS

Wildfire gaseous emissions are primarily acidic (low pH)

Particulate settled wildfire “ash” is caustic (high pH)

Normal background –	**5.8 – 8.3**
Ash possible -	**8.5 – ~9.0**
Elevated pH – ash-likely	**9.0 – 10.0**
High pH - high ash content	**>10.0**

AUTOMATED ANALYSIS – A SYSTEMATIC APPROACH TO PARTICLE CLASSIFICATION



Applications-

Fire ash analysis

Respirable quartz in coal, phosphate, and other mining dust

Corrosion particle contamination in indoor air quality samples

Determining the generation sources of mixed samples

AUTOMATED ANALYSIS – A SYSTEMATIC APPROACH TO PARTICLE CLASSIFICATION

Chemical Classification Hierarchy -

Mixed carbon – Carbon > 50% - Mixed elemental concentrations <10%

Silicates - Al, Na, Mg, K, Ca, Ti, Fe (mixed clays)

Carbonates - Ca, Mg, Ba, other

Oxides - Si (quartz), Ca, Fe

Sulfates - Ca, Mg, other

Chlorides - Al, Ca, Fe, Al

Metal/metal oxides – Al, Cr, Fe, Zn, Cu

PARTICLE CLASSIFICATION → PARTICLE SOURCE

Carbon – **Biogenic particles, decay, coatings, combustion**

Silicates - **Quartz, construction materials**

Al Silicates – **Clays, mixed minerals, construction materials**

Carbonates – **Common minerals, construction materials**

Sulfates – **Drywall, precipitated salts, etc.**

Chlorides – **Salts, metal corrosion**

Metal/metal oxides – **Corrosion / abrasion**

CLASSIFICATION → SOURCE LIBRARY

Run a "pre-scan" of the sample to determine the appropriate comparison library, or customize a library.

EXAMPLE DATA ANALYSIS LIBRARIES

CARBONACEOUS – Biogenic, fire residue, plastics, etc.

SOIL MINERALS – Quartz, Carbonates, Sulfates, Heavy minerals

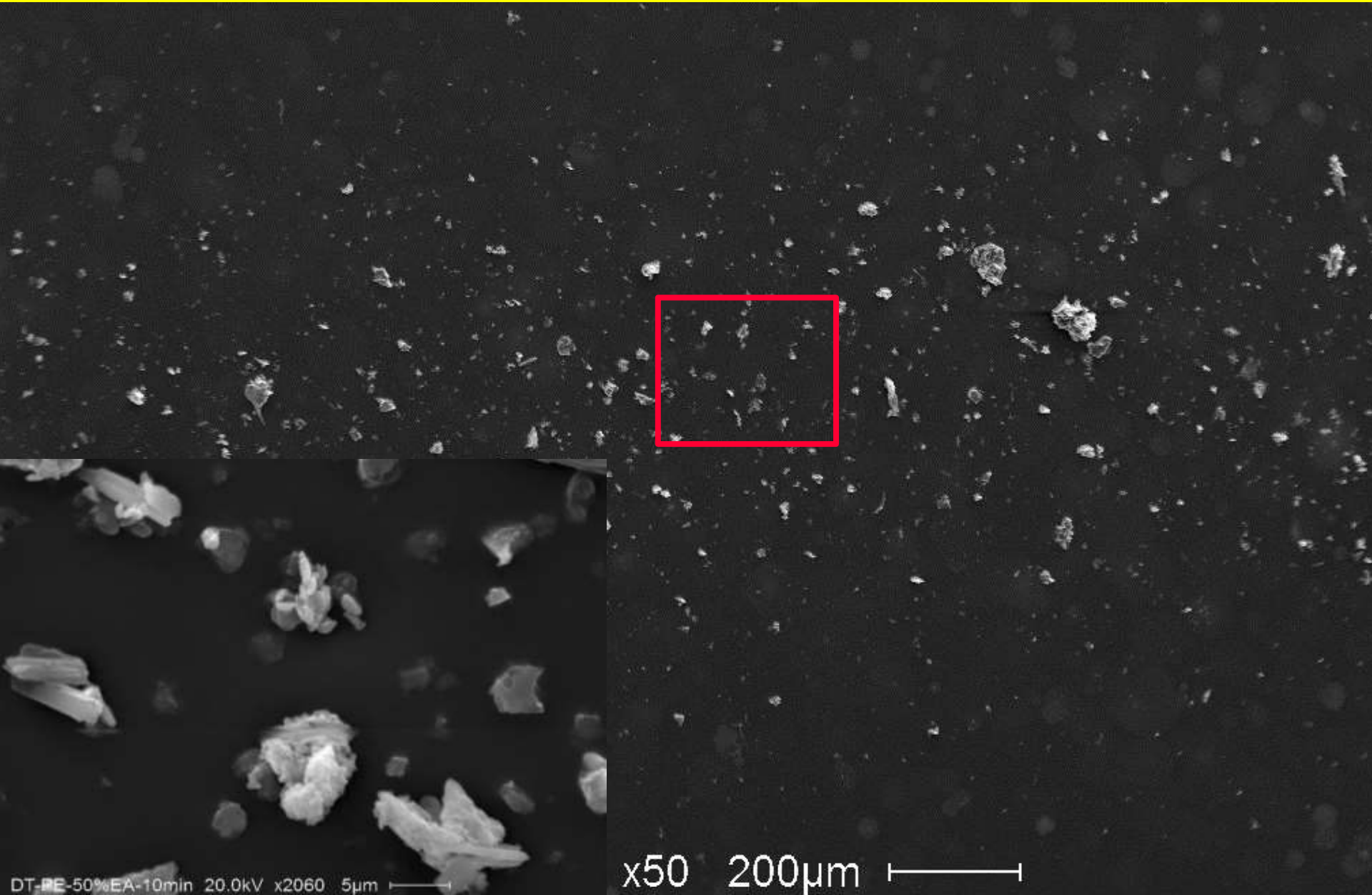
CONSTRUCTION – Minerals, composite formulations

CORROSION / ABRASION – Metal oxides / chlorides

FIRE RESIDUE – Carbonaceous, salts, oxides, carbonates

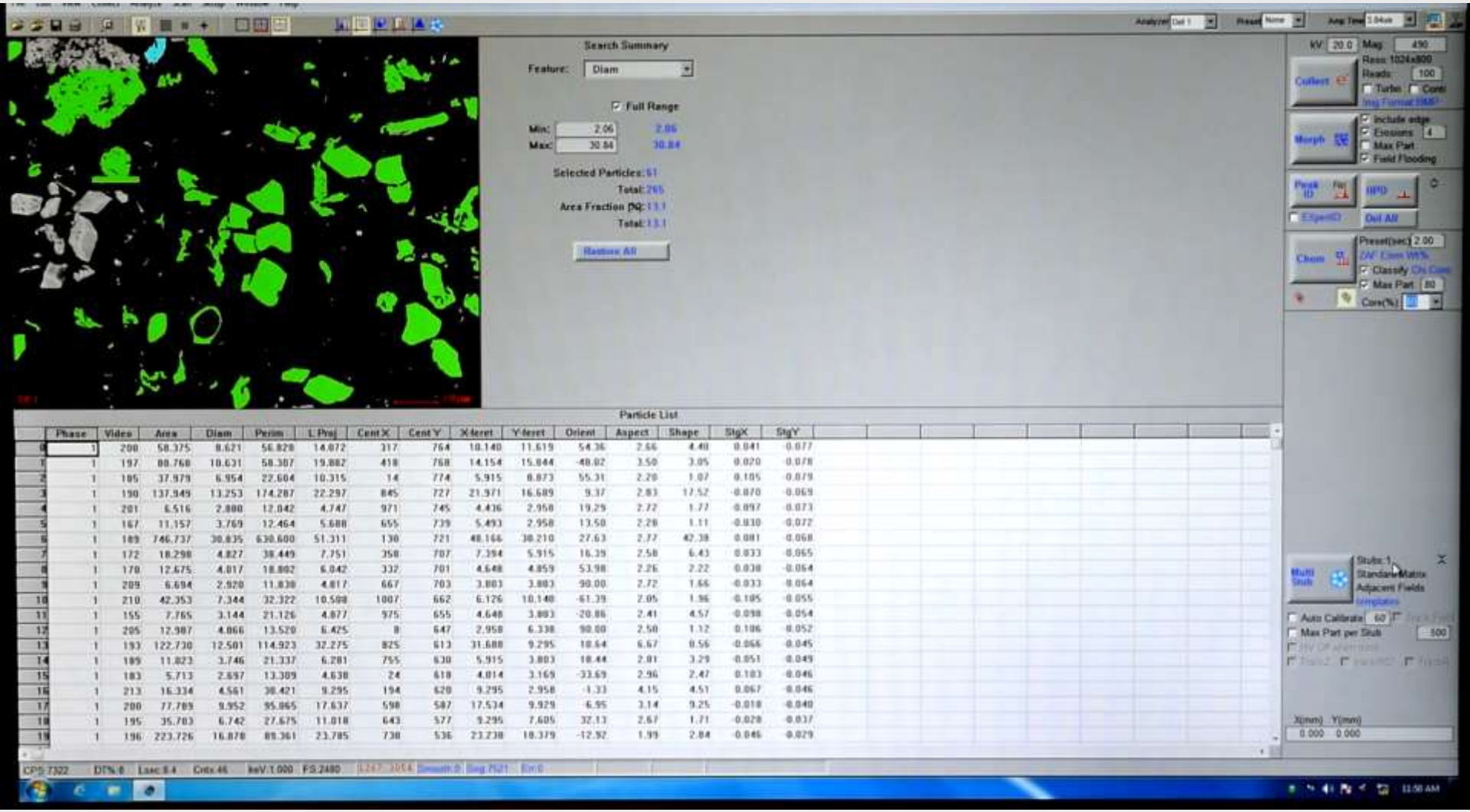
AUTOMATED SEM ANALYSIS REPORTING

New CSI media - air sample



NEW INSITE USING AUTOMATED SEM/EDS

FIRE ASH ANALYSIS



AUTOMATED SEM ANALYSIS REPORTING

Example Summary reporting table excerpts – Fire ash

Environmental Analysis Associates, Inc. • 5290 Soledad Road • San Diego, CA 92109 • (858) 272-7747

Automated Scanning Electron Microscopy - Dust Analysis Report

Summary Page

Client Name :	Michigan fire ash	Analysis Date :	1/7/15
Contact :	Daniel Baxter	EAA Project # :	Research
Client Project# :	Research	EAA Sample # :	1000-1
Client Sample # :	1000-1		
Sample Description :	Michigan fire ash sample on carbon tab	Fields Counted :	1
Analysis Method :	Automated SEM/EDS	Field area cted (mm^2) :	0.034
Analysis Magnifcation :	504	Particles / mm^2 :	2904
Min. size threshold (um) :	1.0	Scale (pm/div.) :	1
Max. size threshold (um) :	50	Total particles counted :	100

SUMMARY CONCLUSIONS - Major Constituents

Fire ash is primarily composed (>60% mass) of Calcium oxide/oxalate and Calcium carbonate particles. The large angular crystals are primarily Calcium oxide or oxalate.

Minor Constituents:

Minor concentrations of carbonate partices containing Magnesium and Potassium are also present. The "unclassified" particles contain minor amounts of Zinc

Particle Classification	Particles Counted	Mean size (um)	* Specific Gravity	Numerical %	* Mass Ratio %
Carbon M	30	2.5	1.30	30.0%	3.8%
Al Silicate	3	9.8	2.00	3.0%	7.6%
MgAlkCa silicate	6	2.7	3.00	6.0%	1.5%
Ca oxide	15	11.2	3.00	15.0%	57.4%
Ca carbonate	25	3.8	3.00	25.0%	23.6%
MgCa carbonate	10	3.4	3.00	10.0%	3.7%
MgKP carbonate	2	2.0	3.00	2.0%	0.2%
MgK carbonate	5	3.8	3.00	5.0%	2.0%
Unclassified	4	1.9	2.00	4.0%	0.2%

** Mass ratios are based on the average particle size & theoretical specific gravity. If the specific gravity is unknown and not "carbonaceous", it will automatically be assigned a density value of 2.0 "Unclassified" particles fall outside of the established chi square rule fit criteria*

Analysis Method : Automated EDAX Genesis X-ray particle analysis software integrated with a data libraries developed by Environmental Analysis

Analyst : Daniel M. Baxter Date : 1/7/15

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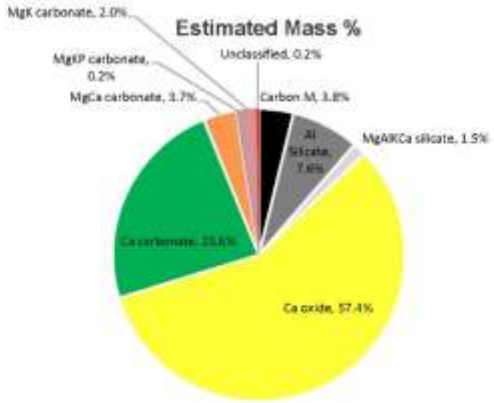
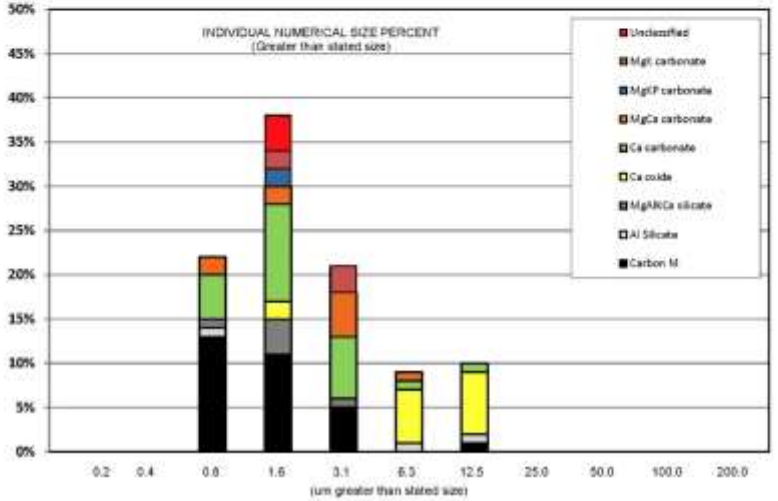
Automated Scanning Electron Microscopy -Grapical Report - Mass & Size Distribution

Client Name :	Michigan fire ash	Analysis Date :	1/7/15
Contact :	Daniel Baxter	EAA Project # :	Research
Client Project# :	Research	EAA Sample # :	1000-1
Client Sample # :	1000-1		
Sample Description :	Michigan fire ash sample on carbon tab		
Analysis Method :	Automated SEM/EDS		





WHAT ARE BACKGROUND "FIRE RESIDUE" LEVELS?

FACTORS –

1. Geographic region, time of year, micro-meteorology
2. Prevalence of outdoor wood burning activities, barbecues, tail pipe, and stack sources.
3. Prevalence of indoor combustion activities(cooking, fireplaces).
4. History of forest fires or outdoor burning activities upwind and for up to 200 miles away.
5. Time between surface cleaning and sampling

Extreme care must be exercised when using lab analysis to support allegations of "damage".

PRELIMINARY DATA

Exponent (General conclusions)

Most large soot, ash, and char, particles fall within a 0.25 mile perimeter.

60% or less (of the total particle mass) is composed of carbon.

Carbonaceous xerogels, resins, and carbonized organic materials form the “aciniform” soot debris

PRELIMINARY DATA

Exponent – Bastrop TX Fire

TYPE – Residences in the "burn" area

Location	g / 3 ml	pH	Numerical % Soot	Ash	Char
1	0.130	7.8	0.1	ND	4.9
2	0.110	7.5	0.1	0.9	7.1
3	0.003	8.8	5.3	1.1	33.5
4	0.102	7.2	1.6	0.6	15.1
5 *gray ash	0.041	10.2	0.1	ND	26.1
6 *gray ash	0.530	10.9	1.2	0.4	18.6

**** When "gray ash" is present, the pH is increased***

PRELIMINARY DATA

Exponent – Bastrop TX Fire Upwind / Downwind Data

Location		g / 3ml	pH	Soot	Ash	Char
UPWIND 11 - 29 Mi.						
12	11mi.	<0.001	NA	ND	ND	ND
13	12	<0.001	NA	0.4	ND	ND
14	12	<0.001	7.8	0.2	ND	ND
16	29	0.006	8.0	0.2	ND	ND
Downwind 0.25 – 10 miles						
7	0.25mi	0.001	8.3	0.1	ND	1.7
8	0.5	<0.001	7.9	0.2	ND	0.7
9	1.1	<0.001	NA	0.1	ND	0.2
10	5.0	0.001	7.6	0.1	0.1	0.5
11	10	0.001	7.3	ND	ND	ND

PRELIMINARY DATA

Submitted for publication by Exponent

PRELIMINARY CONCLUSIONS – Bastrop TX fire

pH is higher at the fire site & drops rapidly at >1/4 mile downwind

Heavy metal concentrations were elevated at the fire site. Levels fell rapidly outside of 1/4 mile.

No PNA compounds were found in the samples collected.

PNA'S & PAH'S are likely "incinerated" at the high fire temperatures found in wildfires.


THE
END

CLEARANCE / CONTAMINATION CRITERIA ?

Suggested Guidelines - Analytical

Recommend "tape lift" sampling for surface analysis
Recommend "slit impaction sampling" for airborne (where requested)

WILDFIRES:

Visual parameters are primary, analysis results are secondary

Optical Microscopy – Char, ash, and soot <1-3% depending on location
Confirm absence of "ash" if "char" is "detected"– pH analysis or SEM / X-ray
Organic compounds – Not necessarily, helpful only in close time proximity to fire.

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STRUCTURE FIRES:

Visual parameters are primary, analysis results are secondary

Optical Microscopy – Soot & Char <1-3% depending on location criteria
Organic compounds – Very helpful
Absence of fine "ash" and "soot" – Use of SEM / X-ray as confirmation
Metals or asbestos analysis if the materials were present

WHAT IS DAMAGE ?

Damage is an alteration to the appearance, function, or usability of a surface or object.

An argument commonly ensues as to whether the alteration is temporary or permanent.

Damage cannot be determined by an analytical method alone.

Although determining "damage" is not the direct pervue of an IAQ investigator. The information gathered by an environmental investigation is used by an "adjustor" along with other factors to assess the scope of damage and valuation.

The common microscopy methods employed for fire residue analysis can only determine if the surface or airborne environmental conditions are "typical" or "atypical".

CONCLUSIONS

- A systematic and thorough visual site investigation is required as the primary source of determining indoor contamination.
- Analysis of fire residue must include a proper blend of chemical and microscopic methods.
- More research is needed to determine precise biomarkers such as Levoglucosan.
- Microscopic data should be evaluated in ranges.
- Ash levels (the most corrosive agent in wildfire residue) are chronically under reported when using optical or TEM microscopy methods.
- Ash analysis using automated SEM methods shows significant promise.
- Microscopic or chemical data alone cannot be used as a measure of “damage”.