

High-Speed Particle Analysis using Feature in the ESPRIT Software



Bruker Nano Analytics, Berlin, Germany
Webinar, September, 2020

A blue-themed graphic illustrating EDS technology. It features a central sun-like glow. To the left, a portion of the periodic table is shown with labels for various X-ray emission lines: $K\alpha$, $K\beta$, $L\alpha$, $L\beta$, $M\alpha$, and $M\beta$. Below the periodic table is a circular diagram with arrows pointing outwards, representing a detector or particle interaction. To the right, the text "EDS" and "XFlash® Technology" is displayed. At the bottom, there is a spectrum plot with multiple peaks labeled with element symbols like Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr. On the far right, there are two grayscale images: the top one shows a cross-section of a material with a crack, and the bottom one shows a textured surface.

Presenters



Max Patzschke

Application Scientist EDS
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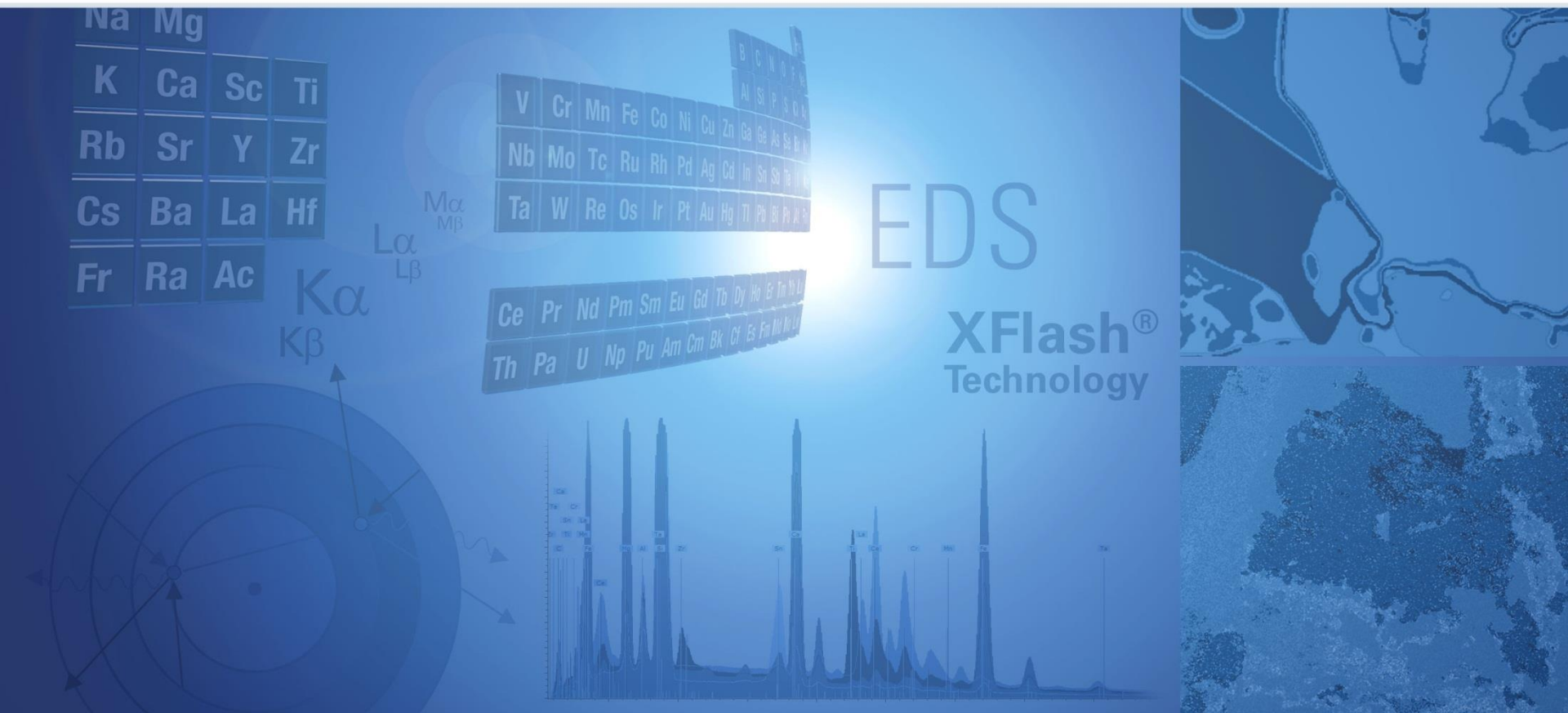
Andrew Menzies, PhD

Sr. Applications Scientist Geology and Mining,
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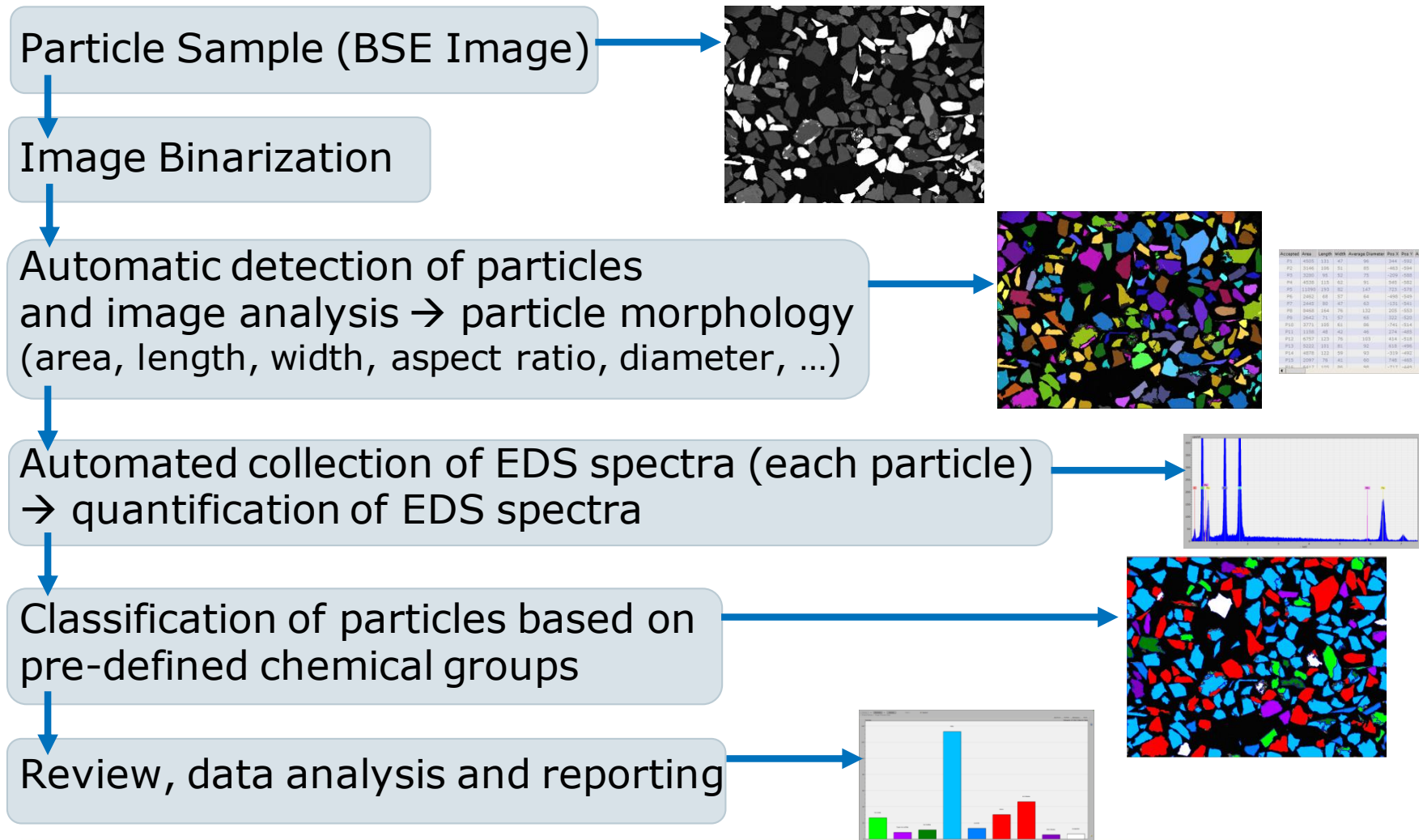
High-Speed Particle Analysis using Feature in the ESPRIT Software



Bruker Nano Analytics, Berlin, Germany
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Feature in the ESPRIT Software: Particle Analysis Workflow



Example

Reference Standard: KC1a



CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

REFERENCE ZINC-LEAD-TIN-SILVER ORE KC-1a

CERTIFICATE OF ANALYSIS

Recommended Values * 95% Confidence Interval		
Zn	34.65	* 0.15%
Pb	2.24	* 0.03%
Cu	0.629	* 0.015%
Sn	0.61	* 0.02%
Ag	0.167	* 0.002%

WARNING

Bottles of KC-1a have been sealed under nitrogen in laminated foil pouches to provide longterm protection against oxidation during storage at CANMET. The recommended values for the certified elements pertain to the date of issue and the Canadian Certified Reference Materials Project cannot be responsible for changes occurring after receipt by the user. It is strongly recommended that opened bottles be stored under an inert gas in a desiccator or in a new heat-sealed foil pouch. Also the contents of the bottle should be exposed to air for the shortest time possible when taking subsamples. Unless these precautions are followed, the recommended values for KC-1a are potentially subject to change.

DESCRIPTION

KC-1a is intended to replace reference ore KC-1 the supply of which is rapidly being depleted. The raw material for KC-1a was hand-

picked at Kidd Creek Mines Ltd. Timmins, Ontario, and is from a zone of massive sphalerite-pyrite containing native silver and galena. It was dry-ground to minus 74 µm, blended and bottled in 200 g units. The stock was sampled systematically and analyzed for zinc and silver by chemical procedures to demonstrate homogeneity sufficient for use as a compositional reference material.

Mineralogical composition	
Mineral	Mass %
Sphalerite	51.7
Quartz	21.4
Pyrite	17.1
Galena	2.6
Chalcopyrite	1.8
Cassiterite	0.8
Silver	0.16
Carbon	0.02



- This is an ore sample from CCRMP.
- Commonly used for whole rock XRF analysis.
- Sample is crushed to -74 µm.
- Known elemental concentrations and mineralogy.
- Sample from Kid Creek Mines Ltd. (Timmins, Ontario, Canada) from a zone of massive sphalerite-pyrite containing native silver and galena.

Mineralogical composition

Mineral	Mass %
Sphalerite	51.7
Quartz	21.4
Pyrite	17.1
Galena	2.6
Chalcopyrite	1.8
Cassiterite	0.8
Silver	0.16
Carbon	0.02

Feature: Data Processing Chemical Classification



Measurement Conditions

Classification Criteria

EDIT CHEMICAL CLASSIFICATION

Measurement time

1st Tier - Normal 2nd Tier - Extended

Automatic Precise Automatic Exhaustive

Real time [s] 60 Real time [s] 30

Live time [s] 0,2 Live time [s] 30

Counts 30000 Counts 100000

Region start [keV] 0,00

Region end [keV] 15,00

Scan full particle Guard band size [µm] 0

Discard if no hits

Unclassified if mass% < 30 %

Max particles per field 200

Max particles overall 100000

Max hits overall 0

Automatic analysis

EDS MinClassQuant - KC1Av1

Chemical particle properties 10 Classes

Add class Delete class |< < 0 > >|

Class name: Ag-Bearing Hit class ^ v

Class description: Silver

Treat unclassified particles as hits Duplicate Erase all

Active	Primary	Oper.	Secondary	Type	Min.	Max.
<input checked="" type="checkbox"/>	Ag			Mass % (norm.)	20,0	100,0

+ Add

Color palette

Ag-Bearing	Chalcopyrite (CuF...	Quartz (SiO ₂)
Sphalerite (ZnS)	Cu Sulphide	Silicate
Pyrite (FeS ₂)	Cassiterite (SnO ₂)	
Galena (PbS)	Fe-Oxide	

Classifier: MinClass - KC1Av2 Ready.

Description: Classification Minerals KC1A

Load Save

Apply Cancel

Feature: Data Processing Chemical Classification



Measurement Conditions

Set up Quantification Method

- Important for ability to classify minerals or phases correctly
- Affects overall analytical time

EDIT CHEMICAL CLASSIFICATION

Measurement time

1st Tier - Normal 2nd Tier - Extended

Automatic Precise Automatic Exhaustive

Real time [s] 60 Real time [s] 30

Live time [s] 0,2 Live time [s] 30

Counts 30000 Counts 100000

Region start [keV] 0,00

Region end [keV] 15,00

Scan full particle Guard band size [μm] 0

Discard if no hits

Unclassified if mass% < 30 %

Max particles per field 200

Max particles overall 100000

Max hits overall 0

Automatic analysis

EDS MinClassQuant - KC1Av1

Classifier: MinClass - KC1Av2 Ready.

Description: Classification Minerals KC1A

Chemical particle properties

Add class Delete class |< >| 0 > >|

Class name: Ag-Bearing Hit class

Class description: Silver

Treat unclassified particles as hits Duplicate Erase all

Active	Primary	Oper.	Secondary	Type	Min.	Max.
<input checked="" type="checkbox"/>	Ag			Mass % (norm.)	20,0	100,0

Color palette

Ag-Bearing	Chalcopyrite (CuF...	Quartz (SiO2)
Sphalerite (ZnS)	Cu Sulphide	Silicate
Pyrite (FeS2)	Cassiterite (SnO2)	
Galena (Pbs)	Fe-Oxide	

Load Save

Apply Cancel

METHOD EDITOR - MINCLASSQUANT - KC1AV1

Settings

Elements

Use spectrum elements

Use list elements

Search additional elements

H						He
Li	Be					B C N O F Ne
Na Mg						Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn						Ga Ge As Se Br Kr
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd						In Sn Sb Te I Xe
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn						
Fr Ra Ac						
	Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu					
	Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr					

Clear all

Minimum concentration 2.00 %

Element overview list

Standards

Background settings SEM, Automatic

Deconvolution settings Series fit

Quantification model P/B - ZAF

Additional settings

Description

Automatic element ID - 0.5 wt.% minimum -C deconvolution

Load Save To project Apply

Feature: Data Processing Chemical Classification



Mineral or Phase
Classification Name

Classification
Criteria

EDIT CHEMICAL CLASSIFICATION

Automatic analysis
EDS MinClassQuant - KC1Av1

Chemical particle properties

Add class Delete class |< < 1 > >|

Class name: Sphalerite (ZnS) Hit class ^ v

Class description: Sulphide

Treat unclassified particles as hits Duplicate Erase all

Active	Primary	Oper.	Secondary	Type	Min.	Max.
<input checked="" type="checkbox"/>	S			Mass % (norm.)	20.0	50.0
<input checked="" type="checkbox"/>	Zn			Mass % (norm.)	40.0	80.0

Color palette

● Ag-Bearing	● Chalcopyrite (CuFeS ₂)	● Quartz (SiO ₂)
● Sphalerite (ZnS)	● Cu Sulphide	● Silicate
● Pyrite (FeS ₂)	● Cassiterite (SnO ₂)	
● Galena (PbS)	● Fe-Oxide	

Classifier: MinClass - KC1Av2 Ready.

Description: Classification Minerals KC1A

PARTICLE PROPERTIES

Main element

H	He
Li Be	B C N O F Ne
Na Mg	Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr	
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe	
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn	
Fr Ra Ac	Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr	

Secondary element

H	He
Li Be	B C N O F Ne
Na Mg	Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr	
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe	
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn	
Fr Ra Ac	Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr	

Please specify an element for this rule.

Properties

Mass percent

Mass percent (norm.)

Atomic percent

Net intensity

Stoich. percent

Stoich. percent (norm.)

Operator

None -

< *

> /

+

No operator is required for a rule based on a single element. Use the operator "+" for the sum of two elements, or "/" for an inter-element ratio.

Mineral /
Phase Class

Applied
Hierarchically

Feature: Data Processing Chemical Classification



Mineral or Phase
Classification Name

Classification
Criteria

EDIT CHEMICAL CLASSIFICATION

Automatic analysis
EDS MinClassQuant - KC1Av1 ▾

Chemical particle properties

1

Class name: Sphalerite (ZnS) Hit class

Class description: Sulphide

Treat unclassified particles as hits

Active	Primary	Oper.	Secondary	Type	Min.	Max.
<input checked="" type="checkbox"/>	S			Mass % (norm.)	20.0	50.0
<input checked="" type="checkbox"/>	Zn			Mass % (norm.)	40.0	80.0

Color palette

● Ag-Bearing	● Chalcopyrite (CuFeS ₂)	● Quartz (SiO ₂)
● Sphalerite (ZnS)	● Cu Sulphide	● Silicate
● Pyrite (FeS ₂)	● Cassiterite (SnO ₂)	
● Galena (PbS)	● Fe-Oxide	

Classifier: MinClass - KC1Av2 Ready.
Description: Classification Minerals KC1A

PARTICLE PROPERTIES

Main element

H	He
Li Be	B C N O F Ne
Na Mg	Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr	
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe	
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn	
Fr Ra Ac Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu	
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr	

Secondary element

H	He
Li Be	B C N O F Ne
Na Mg	Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr	
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe	
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn	
Fr Ra Ac Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu	
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr	

Please specify an element for this rule.

Properties

Mass percent

Mass percent (norm.)

Atomic percent

Net intensity

Stoich. percent

Stoich. percent (norm.)

Operator

None -

< *

> /

+

No operator is required for a rule based on a single element. Use the operator "+" for the sum of two elements, or "/" for an inter-element ratio.

Mineral /
Phase Class

Applied
Hierarchically

Feature: Data Processing Results



The following information is available for review and extraction:

- Field (Panorama)
- Particle Image,
- Particle Data,
- Particle Classification,
- Particle Spectrum, and
- Quantification Results

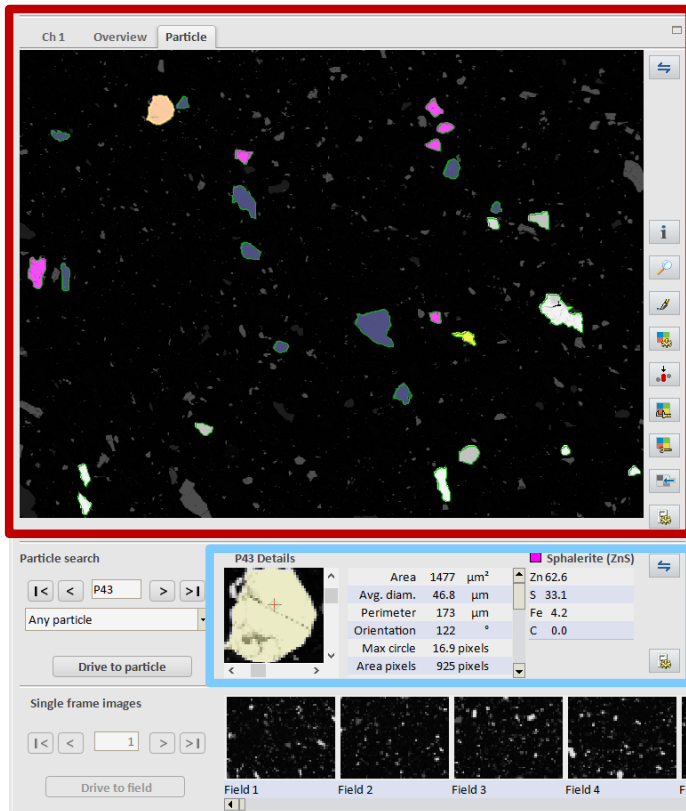
Review functionality

- Results can be sorted according to classes
- Search for and drive to specific particle or field
- Check for Important Particles (Hit Classes)
- Re-classification and/or re-quantification without re-acquisition

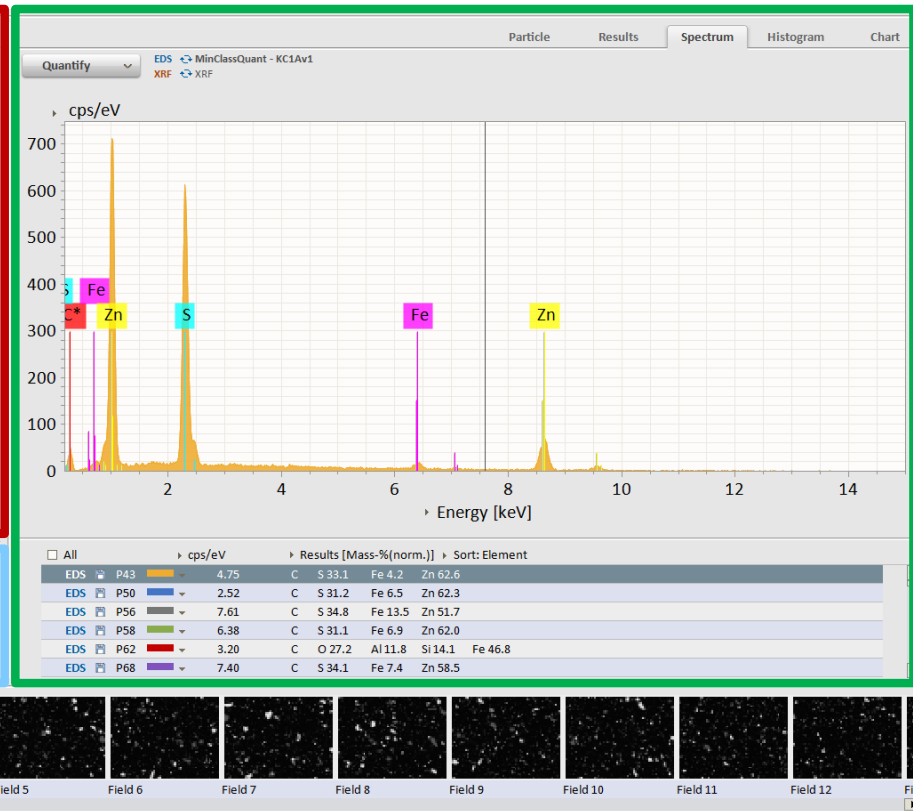
Feature: Data Processing Results



Field and Particle Image



Particle Spectrum and Quantification Results



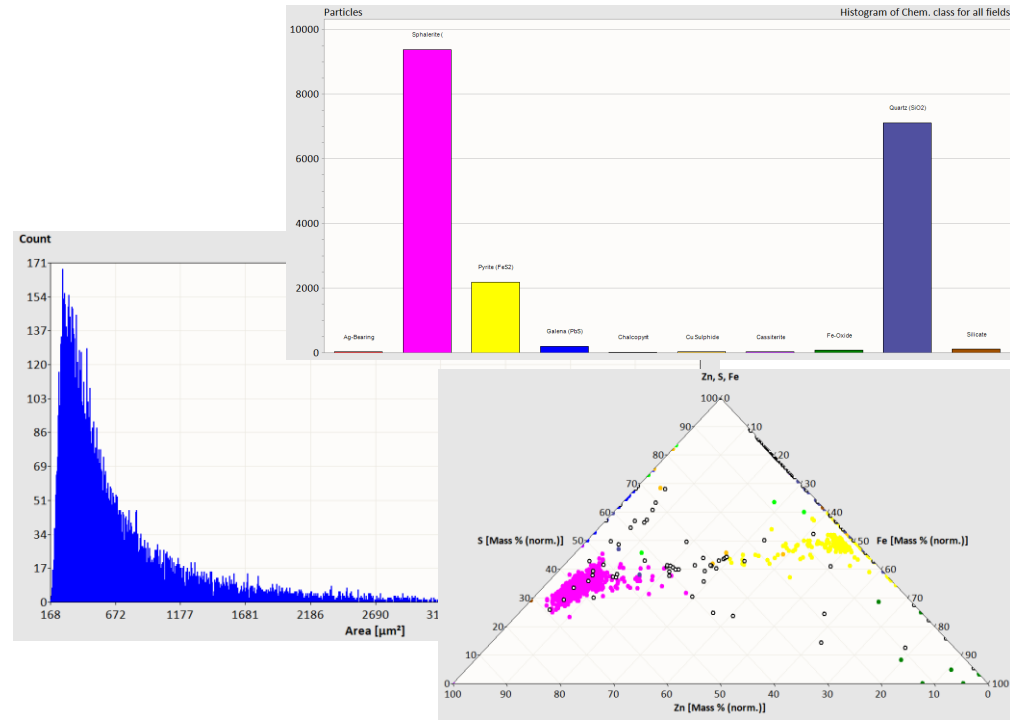
Particle Data, Classification and Quantification Results

Feature: Data Processing

Data analysis: histograms and charts



- Available diagrams for data analysis and reporting:
 - histogram
 - binary charts
 - ternary charts
- Any particle property (morphological parameter) or element (wt%, atom%, ...) can be plotted
- Link between data point in diagrams, particle list and spectrum to find specific particles of interest



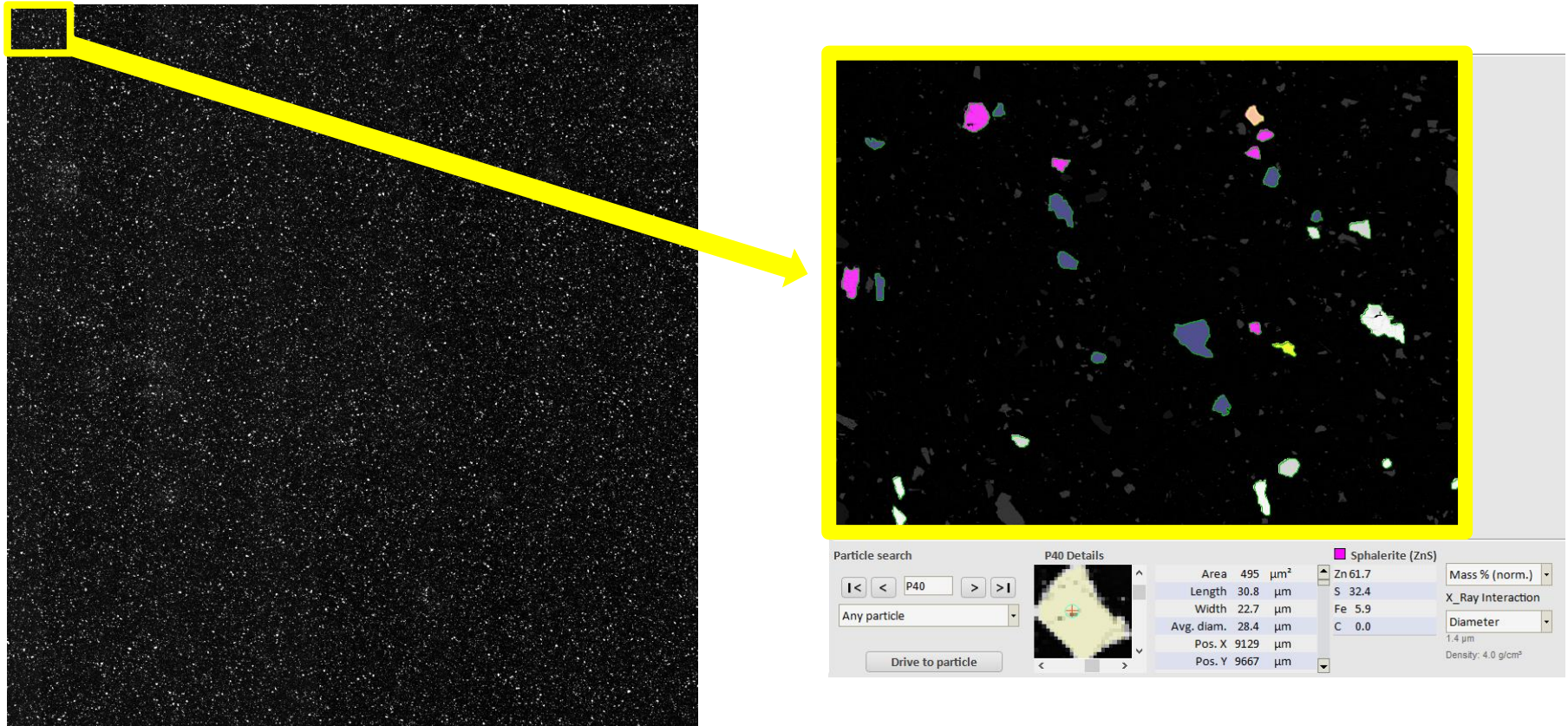
Chem. class	Count	Area	Average diameter	Perimeter	Orientation	Max circle radius	Area in pixels	Volume of sphere	Equivalent diameter
Ag-Bearing	13	773	33.6	114	68	11.6	484	57760	30.0
Sphalerite (ZnS)	4695	688	31.5	104	67	10.5	431	52311	27.5
Pyrite (FeS2)	1095	701	31.6	104	64	10.4	439	54665	27.5
Galena (PbS)	102	688	31.8	105	65	10.5	431	51942	27.8
Chalcopyrite (CuFeS2)	10	562	30.4	96	61	9.9	352	33911	26.1
Cu Sulphide	14	643	29.0	95	50	9.9	403	51108	25.4
Cassiterite (SnO2)	16	622	29.4	93	73	10.1	390	45437	25.8
Fe-Oxide	40	786	33.2	112	67	11.0	492	66256	29.1
Quartz (SiO2)	3565	637	31.4	101	70	9.9	399	45251	26.9
Silicate	55	593	30.8	99	62	9.7	371	39939	26.2
Unclassified	4423	645	30.1	98	61	9.5	404	49731	25.7
Min		168	15.8	48	0	7.1	105	5132	14.6
Max		5111	97.0	388	179	33.9	3200	863429	80.7
Average		699	32.5	105	82	10.6	438	52575	28.1
Std. dev.		560	12.0	43	53	3.5	351	71739	9.9

Feature: Data Processing Build Panorama



Individual Fields can be combined into single Panorama

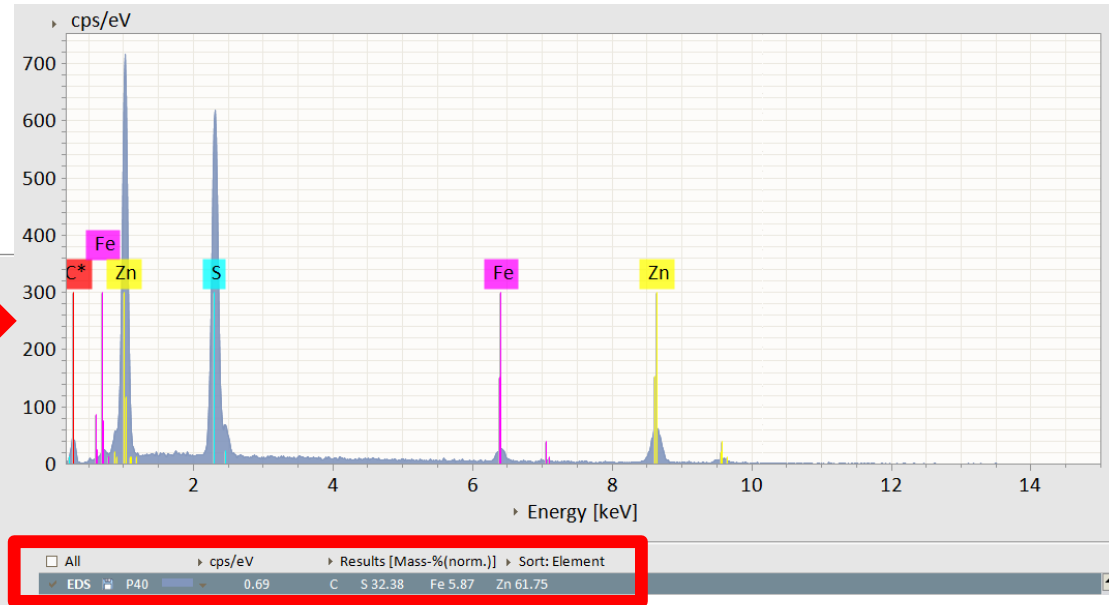
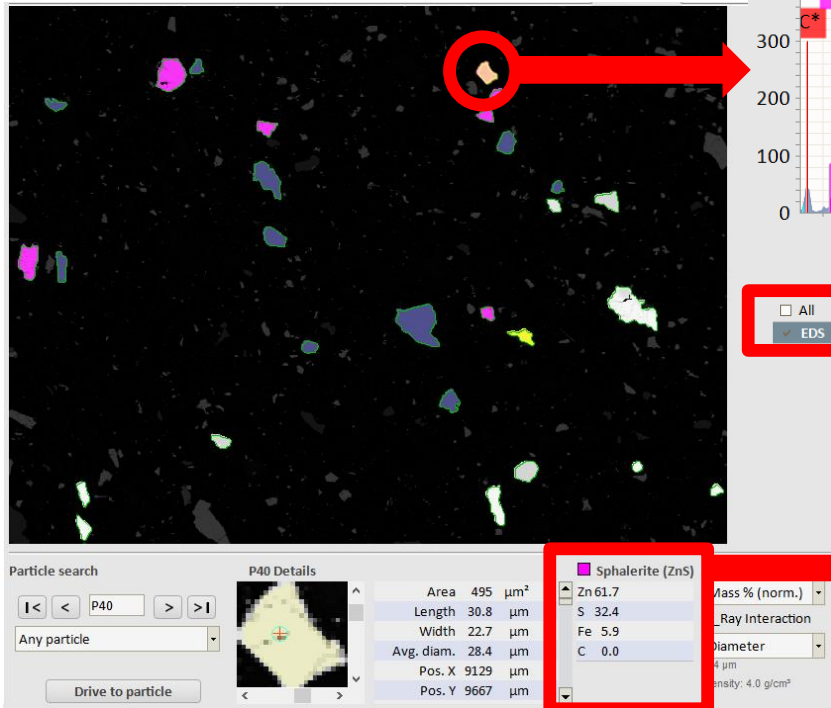
Maintain overall particle locations with sample



Feature: Data Processing Grain Compositions



Individual Grain
Compositions can
be determined



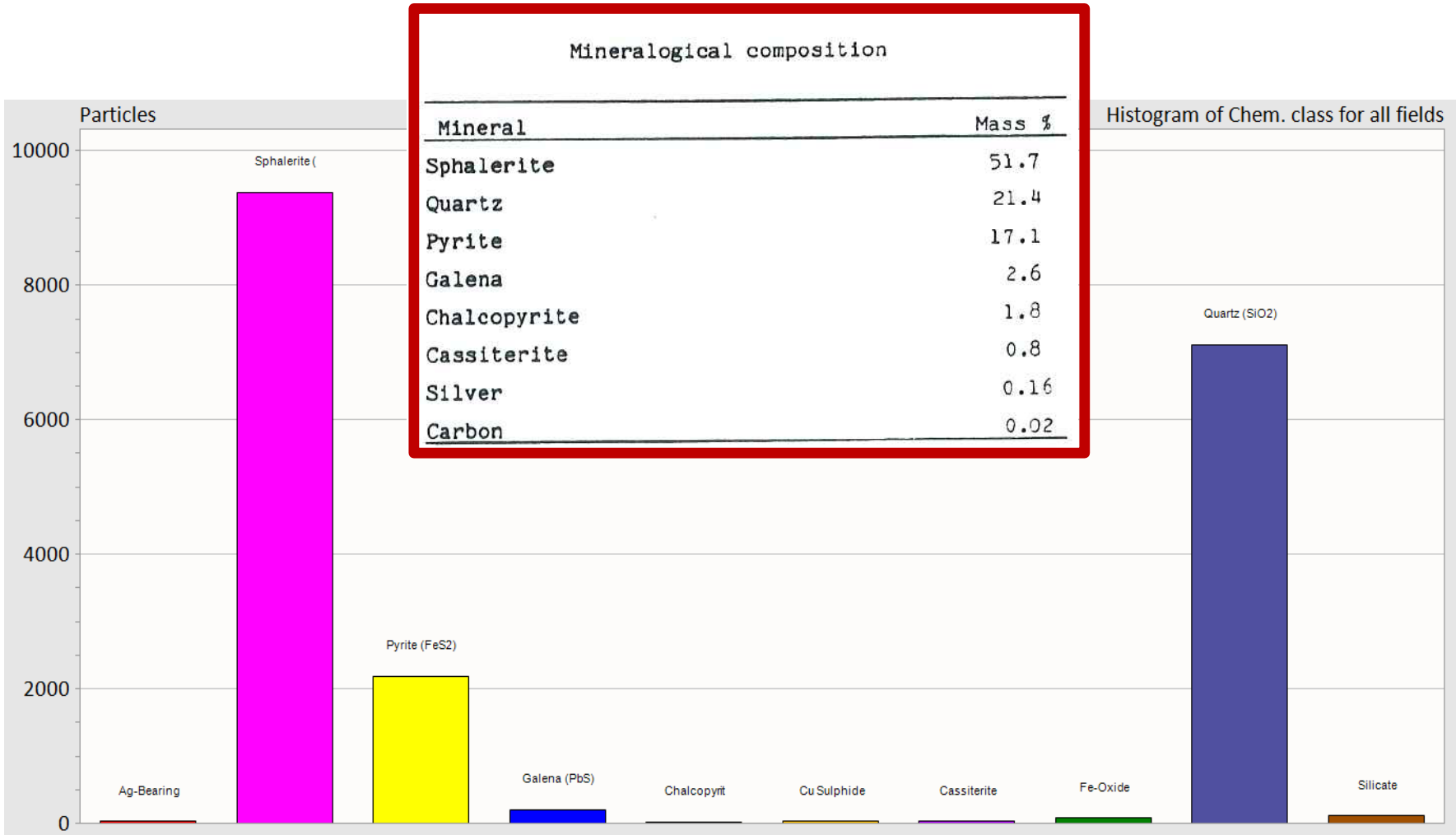
Sphalerite (Zn,Fe)S

Zn = 61.7

S = 32.4

Fe = 5.9

Example: Reference Standard: KC1a Mineralogy

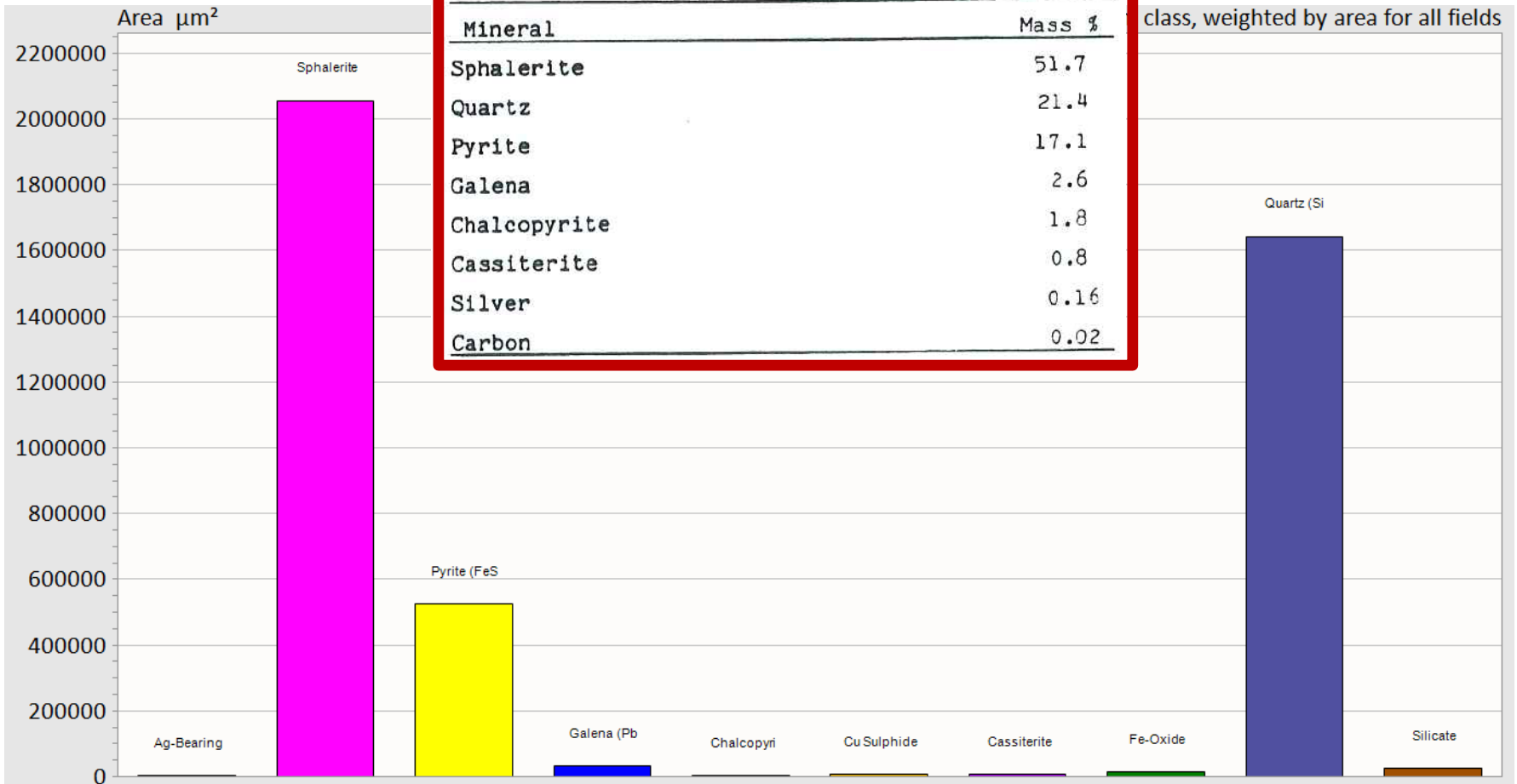


Example: Reference Standard: KC1a Mineralogy



Mineralogical composition

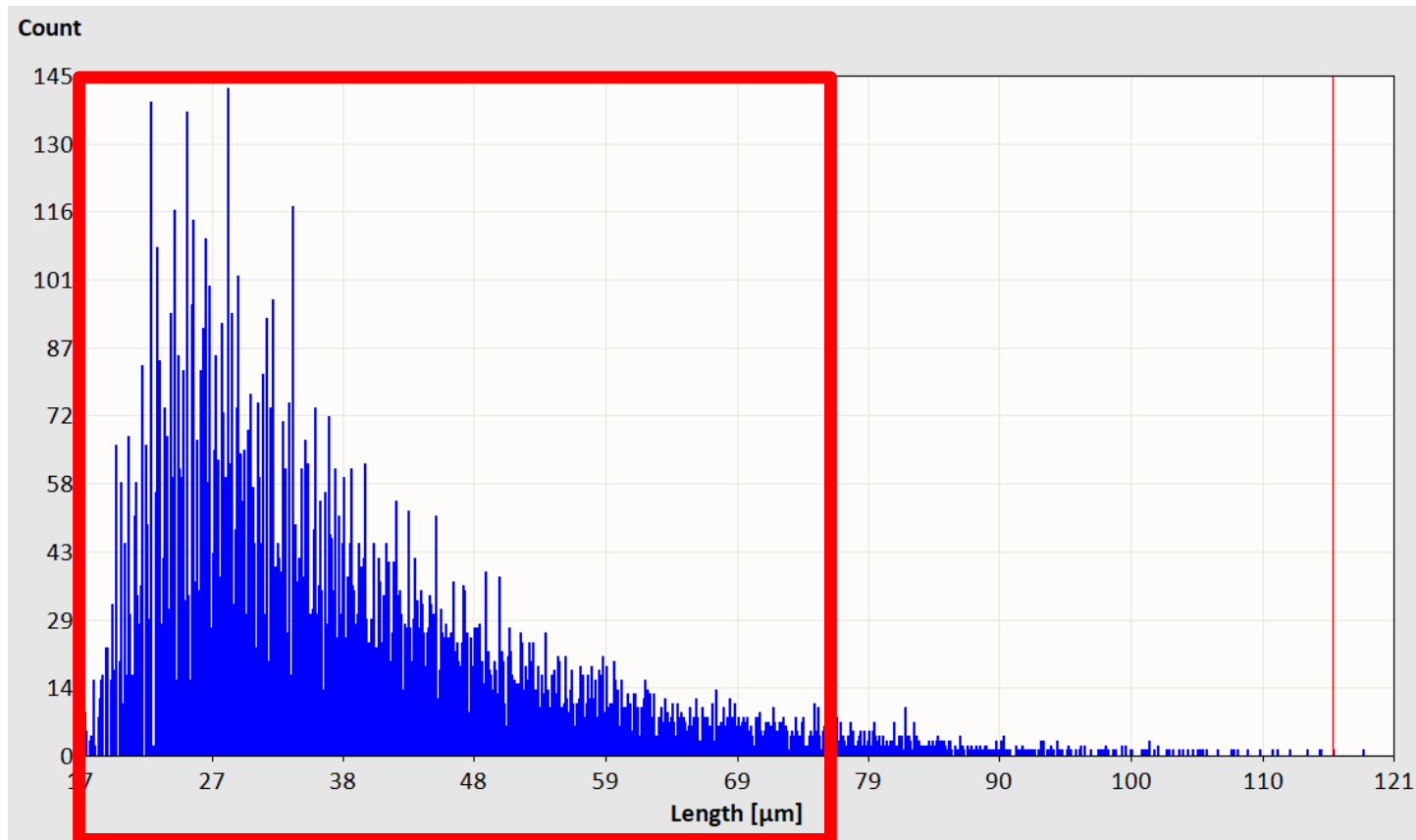
Mineral	Mass %
Sphalerite	51.7
Quartz	21.4
Pyrite	17.1
Galena	2.6
Chalcopyrite	1.8
Cassiterite	0.8
Silver	0.16
Carbon	0.02



Example: Reference Standard: KC1a Grain Sizes



Sample crushed to -74 μm

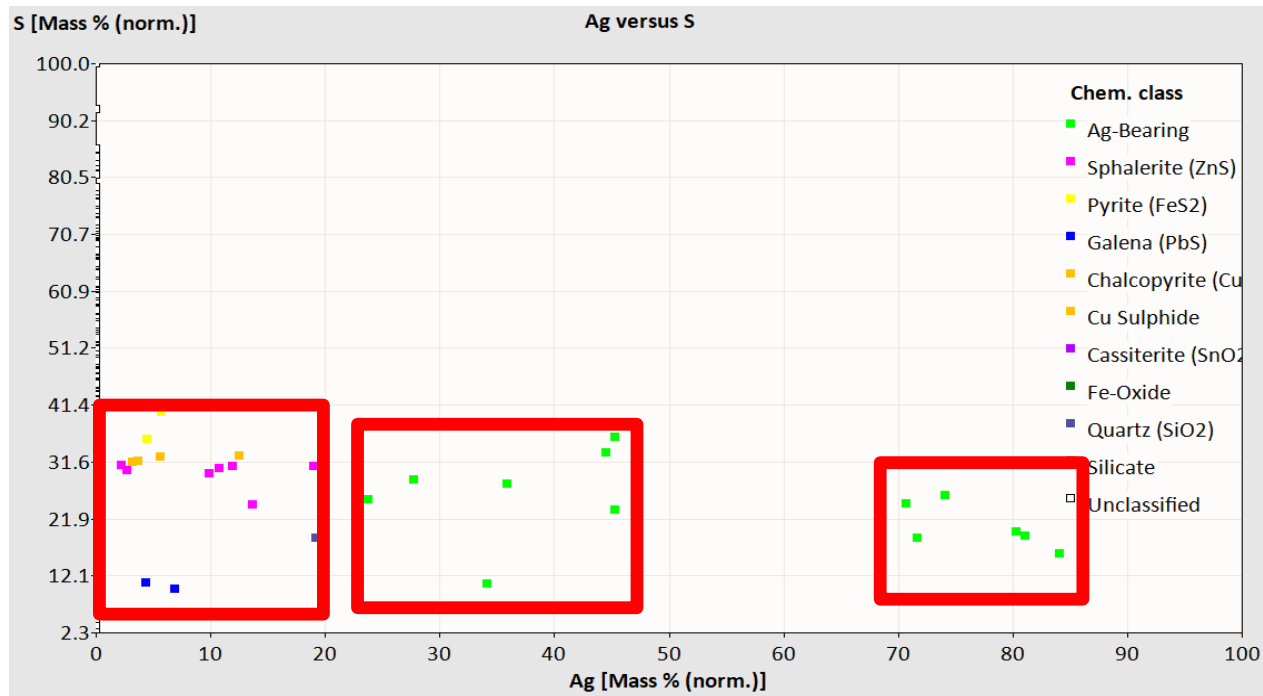


Example: Reference Standard: KC1a Ag-Bearing Phases

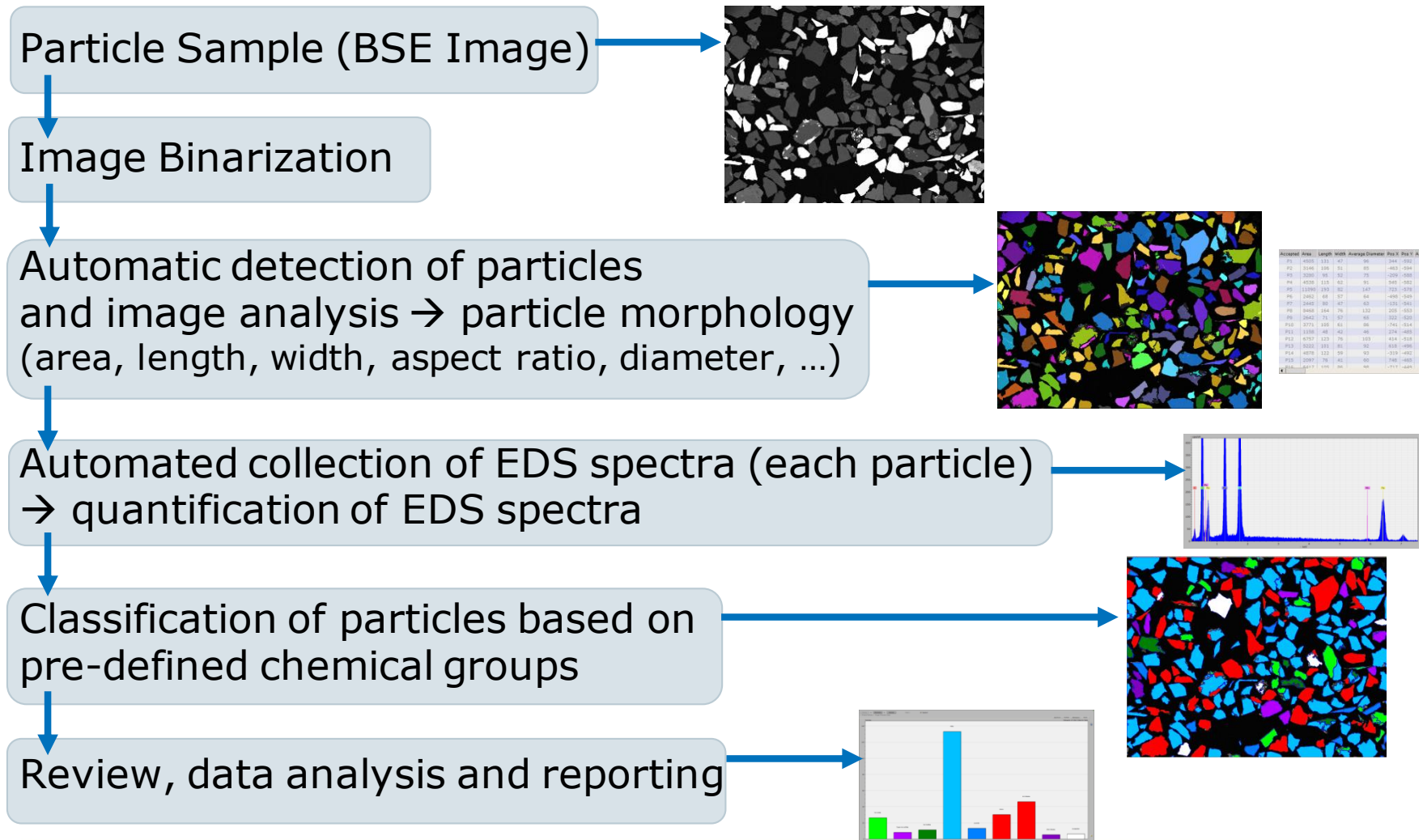


Important Classes:

- Ag-Bearing: Ag-Sulphides
- Other Phases with Ag – likely mixed spectra due to inclusions



Feature in the ESPRIT Software: Particle Analysis Workflow



Feature in the ESPRIT Software: Summary and Conclusion



- Complete and integrated particle analysis with chemical classification
- Morphology: detection of one or multiple phases; loading and analyzing of any image
- Chemical classification: set up hundreds of classes, modifiable quantification method
- Analysis-Method-Development with offline re-classification and re-quantification of results
- Data analysis and reporting with charts and histograms
- Link between particle list, feature image, histogram and spectrum
- Data export (particle list) as text or excel file
- Map data (HyperMap) can also be loaded and used for particle analysis
- Automation: stage movement, analysis of large areas, drive back to frame or particles

Are There Any Questions?

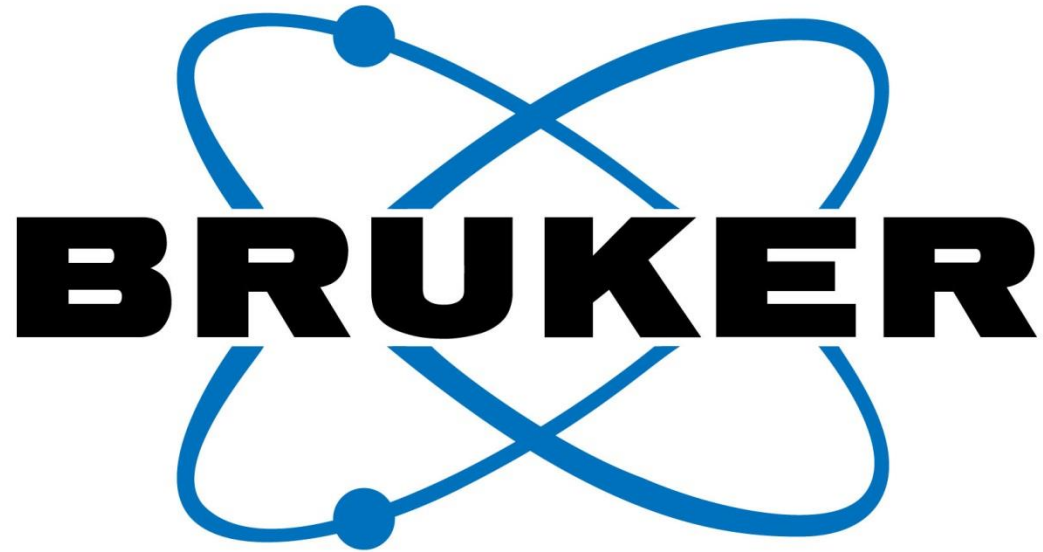
Please type in the questions you might have
in the Q&A box and press *Send*.

More Information



For more information, please contact us:

info.bna@bruker.com



Innovation with Integrity